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FERTILITY AND MODERNITY

Enrico Spolaore
Romain Wacziarg

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ABSTRACT

We investigate the determinants of the fertility decline in Europe from 1830 to 1970 using a newly constructed dataset of linguistic distances between European regions. We find that the fertility decline resulted from a gradual diffusion of new fertility behavior from French-speaking regions to the rest of Europe. We observe that societies with higher education, lower infant mortality, higher urbanization, and higher population density had lower levels of fertility during the 19th and early 20th century. However, the fertility decline took place earlier and was initially larger in communities that were culturally closer to the French, while the fertility transition spread only later to societies that were more distant from the cultural frontier. This is consistent with a process of social influence, whereby societies that were linguistically and culturally closer to the French faced lower barriers to the adoption of new social norms and attitudes towards fertility control.

Enrico Spolaore
Department of Economics
Tufts University
Braker Hall
8 Upper Campus Road
Medford, MA 02155
and NBER
enrico.spolaore@tufts.edu

Romain Wacziarg
Anderson School of Management at UCLA
C-510 Entrepreneurs Hall
110 Westwood Plaza
Los Angeles, CA 90095-1481
and NBER
wacziarg@ucla.edu

Author research website is available at
https://www.anderson.ucla.edu/faculty_pages/romain.wacziarg/papersum.

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1 Introduction

What explains the transition from high to low fertility, occurring in society after society over the past two hundred years? In this paper, we present evidence on the diffusion of the fertility decline in Europe from 1830 to 1970 using a newly constructed dataset of linguistic distances between European regions. We find that the modern decline is the outcome of a gradual diffusion of new fertility behavior from French-speaking regions to the rest of Europe. This is in contrast with the spread of the Industrial Revolution, where England played a leading role. The diffusion of the fertility decline and the spread of industrialization followed different patterns because societies at different relative distances from the respective innovators (the French and the English) faced different cultural barriers to imitation and adoption.

Our contribution bridges the gap between two approaches to the study of fertility. One approach, pursued mainly by economists, emphasizes changes to the incentives for having children, due for instance to urbanization or improved health and human capital (Galor, 2011). The other approach, more popular among demographers, sociologists, and anthropologists, interprets the fertility change in terms of cultural transmission of new values and norms (Coale and Watkins, 1986; Richerson and Boyd, 2005, pp.169-173; Newson et al., 2005; Newson and Richerson, 2009). We do not view the two approaches as substitutes but as complements. In our analysis, fertility choices are impacted by the intrinsic costs and benefits from having children, but also by norms that diffuse across culturally related groups. We present a model where the transition from higher to lower fertility is the outcome of social innovation and social influence. In our framework, higher intrinsic costs or lower benefits from having children are necessary but not sufficient to generate a reduction in actual fertility. What is needed is also a change in the social norms that regulate marital fertility. It is only when traditional attitudes are abandoned and new norms are adopted, lowering the stigma associated with fertility control within marriage, that people change their behavior. At the beginning, only societies close to the cultural innovators experience reduced fertility. Over time, the social innovation spreads to more distant societies.

In the empirical part of the paper, we focus on diffusion across linguistic barriers, while also controlling for variables that affect the economic incentives for fertility choices. We observe that, on average, societies with higher education, lower infant mortality, higher urbanization, and higher population density had lower levels of fertility during the 19th and 20th centuries. However, the fertility decline took place much earlier and was initially larger in communities that were culturally closer to the French, while the fertility transition spread only later to those societies that were more distant from the cultural frontier. Overall, both cultural and economic forces played a significant role in the fertility transition.

We argue that linguistic distance matters in the transmission of fertility decline because individuals in societies that are linguistically closer face lower barriers when they interact socially with each other and learn about new norms and behavior. The effect of linguistic distance on the diffusion of the demographic transition is an important example of how cultural relatedness affects the transmission of innovations across societies. Individuals who are linguistically closer to each other are also on average more closely related, and therefore tend to share intergenerationally transmitted traits that make them more likely to interact with each other and learn from each other. This does not mean that these traits themselves have a direct effect on the probability of adopting the new behavior. Indeed, the new fertility behavior eventually spread to all European populations in our sample, even to those linguistically and culturally farthest from the French. This suggests that linguistic distance captures barriers to the diffusion of innovations, rather than the direct effects of culturally transmitted traits on behavior (for a discussion of this distinction, see Spolaore and Wacziarg, 2013).[1] In sum, this paper provides evidence for a *cultural barrier* interpretation of the effect of social distance on the diffusion of modern fertility behavior.

2 Cultural and Economic Factors in the Fertility Decline

2.1 The Princeton European Fertility Project

The starting point for our analysis is the data about fertility in Europe over the past two centuries collected in the landmark Princeton European Fertility Project (Coale and Watkins, 1986, henceforth PEFP), which was the final product of a massive interdisciplinary research project started in 1963. In the subsequent debate, critics (Guinnane, Okun and Trussell, 1994; Brown and Guinnane, 2007) pointed out several conceptual and methodological issues with the Princeton Project.[2] Nev-

[1] In the Appendix, we also consider genetic distance, a measure of long-term relatedness between populations. We find that genetic distance from the French, like linguistic distance, explains the timing of the diffusion of the fertility decline in a sample of 37 European populations. Populations that were genetically closer to the French faced lower barriers to learn and adopt the new cultural behavior, and did so earlier and to a greater extent. However, *all* the populations in this sample, even those genetically far from the French, eventually transitioned to lower fertility. Genetic distance, like linguistic distance, is properly understood as capturing temporary barriers to the spread of modern fertility behavior.

[2] For instance, some interpretations in the original studies were based on the presumption of a simultaneous adoption of the new fertility behavior by all households across heterogeneous societies. Instead, critics noted that

ertheless, this study remains the most comprehensive source of historical data on fertility across European regions in the 19^{th} and early 20^{th} century, documenting a dramatic decline of fertility in society over society over the past two centuries.

European societies had experienced fluctuations in overall fertility before (Livi-Bacci, 2001). However, in pre-modern times fertility control and decline took place mostly through marriage postponement and celibacy.[3] Demographers call such forms of control *nonparity-specific*, meaning that they affect the probability of conception irrespective of the number of children already produced. In contrast, PEFP authors have attributed the modern fall in fertility to *parity-specific* limitations (Coale, 1986, pp. 9-10), defined as behavioral changes that married couples adopt in order to avoid additional births after the desired number of children has been born. The ideal to "marry, have a couple of kids, and stop," is a modern innovation, which spread across European populations only during the 19^{th} and early 20^{th} centuries. PEFP's critics have questioned this parity-specific interpretation, and argued that marital fertility might also have been reduced through changes in behavior that are typically considered non-parity specific, such as changes in breast-feeding (Guinnane, Okun and Trussell, 1994). In our analysis, we do not take a stand on whether couples limited fertility within marriage through parity-specific limitations or also using non-parity specific controls. The important fact from our perspective is that, starting at the beginning of the 19^{th} century, there occurred a major change in attitudes towards fertility control within marriage that led to much lower observed fertility.

The PEFP provides data on fertility in Europe both at the level of sub-national regions, as well as nation-states. In our empirical analysis, we focus on I_g, the index of marital fertility. For each region or country, I_g is equal to the total number of children born to married women divided by the maximum conceivable number of children, obtained from data on the Hutterites, an Anabaptist sect that does not practice any form of fertility limitations.[4] For any society i:

$$I_{gi} = \frac{B_i^m}{\sum_{j=1}^{N} M_{ij} G_j} \tag{1}$$

the data are consistent with a more gradual transition, in which minorities of households within different societies may have significantly increased their use of fertility control methods, before such behavior spread to most other households in their society (Guinnane, Okun and Trussell, 1994, p. 3). In our theoretical framework in Section 3, we explicitly allow for a gradual diffusion across heterogeneous households within each society.

[3] See Voigtländer and Voth (2013) for a discussion of marriage postponment in Europe starting in medieval times, as a means to reduce total fertility.

[4] See Coale and Treadway (1986), chapter 2, Appendix B, p. 153 in Coale and Watkins (1986).

where B_i^M is the total number of children born to married women, j denotes an age cohort defined at 5-year intervals, M_{ij} is the number of married women in age cohort j and G_j is the Hutterite rate of fertility for age cohort j. The denominator therefore represents the total number of children that could conceivably be generated in society i if it had the age-specific schedule of fertility of the Hutterites, while the numerator is the actual number of children born to married women.

2.2 The Debate in the Literature

The Princeton Project spurred a vigorous debate on the role of economic channels and choices in the demographic transition. According to the leading PEFP authors, the decline in European fertility could not be explained as the direct result of higher income per capita and industrialization (Coale and Watkins, 1986). This contrasted with the view, widespread among economists, that the fertility decline and modern economic development were two sides of the same coin. For instance, a causal mechanism going from higher income to lower fertility was at the center of Becker's (1960) classic argument that industrialization would lead to lower fertility, by increasing the opportunity cost of raising children. However, the pattern of fertility transition in Europe during the 19^{th} and 20^{th} centuries was not consistent with a simple story linking industrialization and lower fertility, because societies at relatively lower levels of development experienced a decline in fertility at the same time, or even before, economically more advanced societies (Coale and Watkins, 1986).[5]

While the decline of fertility in Europe was not a direct result of industrialization, economic incentives could still have played a role in fertility decisions. Substantial empirical support exists for economic theories that connect advancements in health and human capital to a reduction in the incentives to have children. For example, a decline in child mortality enabled families to attain the same number of surviving children with total lower fertility rates (Preston, 1978, Doepke, 2005). Human capital formation also reduced fertility by leading to a substitution of child quality for quantity (Galor and Weil, 2000). Recent empirical analyses have shown that advancements in health and human capital, by increasing the "quality" of children, reduced fertility in the United States (Bleakley and Lange, 2009) and in German regions (Becker, Cinnirella and Woessmann, 2010). According to Murtin (2013), human capital was a fundamental force behind the demographic

[5] Becker's mechanism may not hold empirically because the substitution effect, which should reduce the desired number of children, can be offset by the income effect, which raises desired fertility. Therefore, we should not necessarily expect higher income and productivity to go hand in hand with a decline in fertility. See also the discussion in Galor (2011), chapter 4, p. 118. In the Empirical Appendix, we find that per capita income is not a significant determinants of fertility levels or of the fertility transition date in a sample of 37 European populations.

transition in a worldwide sample of countries.[6] Overall, these economic contributions have provided essential insights on the fertility decline. However, the evidence collected by the Princeton Project suggested that economic forces alone were not sufficient to explain the dynamics of the fertility transition, and that cultural and linguistic variables may have played an important role in the transmission of the new fertility behavior (Richerson and Boyd, 2005, pp. 172-173).

2.3 The Onset of the Fertility Decline in France

A key fact about the modern fertility decline was the pioneering role played by French households, whose fertility permanently declined to low modern levels before 1830. However, there was significant variation across French *départements*, with regions at the cultural and linguistic periphery transitioning to modern fertility much later. For example, in the *départements* of Finistère and Côtes-d'Armor in Brittany, where the traditional language and culture were far from standard French, the first 10% decline in marital fertility only happened in 1905.[7] Similarly, in Belgium during the 19^{th} century, French-speaking households in Wallonia reduced their fertility to modern levels much before Dutch-speaking households in Flanders. As noted by Lesthaeghe (1977, p. 227), "the early adoption of fertility control [...] stopped at the language border. Not only did Flemings and Walloons who lived as neighbors in this very narrow strip along the language border fail to intermarry to a considerable extent, but they also did not take each other's attitude toward fertility. As a result, two separate diffusion patterns developed in Flanders and Wallonia." Remarkably, Walloon and Flemish regions had similar levels of human capital at the time of the fertility transition. For instance, in our data, in 1880 the literacy rate was 59% in French-speaking Liège and 61% in Dutch-speaking Bruges, and yet Liège started its transition to modern fertility in 1875 and Bruges only in 1905. A similar phenomenon can be observed in Spain, where the literacy rate in 1880 was 43% in Barcelona (Catalonia's largest city) and 46% in Bilbao (the largest city in the Basque Country), but Barcelona transitioned to modern fertility in 1865, while Bilbao only in

[6] For a general evolutionary theory of the trade-off between quality and quantity of children and its implications for fertility, see Galor and Moav (2002). A theory of the persistence of poverty that links high fertiliy and low investment in child quality is provided in Moav (2005).

[7] There also exists detailed microeconomic evidence at the village level that the French reduced their fertility *before* the large increase in the supply of schooling due to national policies, such as the Guizot Law of 1833. For instance, see Blanc and Wacziarg (2019) and the references therein.

1925.[8] In this case, again, the key difference seems to be that Catalans spoke a Romance language relatively close to French, while the Basques shared a much more distant ancestral language and culture. We will return to this important point when we discuss the diffusion of the fertility decline from France to the other regions of Europe.

An open question, widely debated by historians and demographers, is why the transition to lower marital fertility started in France. Several factors are likely to have contributed to the onset of the fertility transition within French society. One is the cultural development towards secular modern norms and values, which had already spread among elites and other groups in France during the Enlightenment (or even earlier) and accelerated with the French Revolution. A parallel mechanism points to political and institutional changes that affected the traditional power structure - in particular, the Church and other traditional centers of political and cultural influence - therefore determining or facilitating changes in social norms and behavior. As France started to experience a decline in fertility in the second half of the 18^{th} century, a few contemporary observers attributed the new phenomenon to a change in moral standards. For example, Jean-Baptiste Moheau, in his *Recherches et considérations sur la population de la France* (1778), noticed that the French were having less children than in the past because people had become more focused on their own selfish material interests and were reluctant to bear the high cost of having children, while they no longer felt a moral obligation to reproduce out of religious and civic duty. In a recent study, Blanc (2019) uses a measure of traditional religiosity across different French *départements* in 1791 introduced by Tackett (1986): the percentage of "*clergé réfractaire*," the Catholic priests who refused to accept the authority of the French Revolutionary State over all religious matters. Remarkably, Blanc finds that this religiosity measure has a large and significant impact on fertility a generation later (in 1831). He also finds that subscriptions to Diderot's *Encyclopédie* is negatively correlated with fertility across French *départements* in 1831, even when controlling for industrial output per capita, urbanization, literacy and pre-industrial development. The *Encyclopédie* was a fundamental source of secular philosophy and scientific knowledge that had persistent effects on French long-term development (Squicciarini and Voigtländer, 2015). These findings strongly point to a cultural mechanism to explain the onset of the fertility decline in France, operating through the weakening of traditional religious values and the emergence of secular attitudes.

The effects of the French Revolution and the Napoleonic conquests on modern institutional

[8] Correspondingly, the levels of marital fertility (I_g) averged over the 1881-1910 period were 0.499 in Liège and 0.796 in Bruges, 0.460 in Barcelona and 0.710 in Bilbao.

reforms outside France have been studied by Acemoglu, Cantoni, Johnson and Robinson (2011). Relatedly, Lecce and Ogliari (2019) find that the effect of the (exogenous) adoption of formal Napoleonic institutions on economic performance in German regions depended on cultural (religious and linguistic) proximity to France. Cultural proximity to France is also likely to have impacted the possible effects of secular Napoleonic institutions on fertility, because only people who were culturally close to the French also embraced the social norms that made the new institutions "work", not only *de jure* but also *de facto*. Therefore, such an institutional mechanism is not an alternative explanation for the fertility transition, but it is broadly consistent with our interpretation in terms of cultural diffusion of novel social norms and behavior from France.[9]

As traditional social norms against fertility control weakened, it is also possible that direct knowledge about reproduction control and contraceptive methods became more widespread across the population. However, the fertility transition during the 19^{th} century took place well before modern methods of contraception had become widely available, so that French fertility was reduced to just about two children per woman using rudimentary "natural" methods, such as withdrawal, which had been known since biblical times (van de Walle, 2005, p. 4). In contrast, condoms made from sheep gut or fish bladder were used mainly in brothels and were too expensive for general use. Early condoms were mentioned for the first time in England, not in France, around 1700, and their original purpose was to protect against syphilis; in France, they became known as "redingote d'Angleterre" (English riding coats), while "the other technical innovation of the eighteenth century was the vaginal sponge mentioned for the first time in an English erotic work of 1740" (van de Walle, 2005, p. 3). Therefore, it is plausible to conjecture that the main mechanism behind the onset and spread of the fertility transition, first within France and then from French society to neighboring communities, was not new technological knowledge about contraception but new social norms that reduced the stigma attached to well-known natural methods of fertility control.

2.4 The Diffusion of the Fertility Decline

In our theoretical and empirical analysis, we hypothesize that the novel behavior originally emerged in France and then spread along cultural lines, with populations closer to the French being more

[9] In the empirical analysis, we control for measures of economic development and for country fixed effects, therefore accounting for the direct effects of country-specific formal (*de jure*) institutions on fertility and for the indirect effect of institutions (both *de jure* and *de facto*) on economic performance, which may vary across regions, depending on cultural distance from France.

likely to learn about the new behavior, and more willing to adopt it. That is, in our analysis we focus on the diffusion process, not on the factors that generated the onset.

Our central hypothesis is that the fertility decline can best be understood as a process of diffusion of new social norms and behavioral changes, spreading from early adaptors to imitators. In this respect, the fertility transition was similar to the spread of productivity-enhancing innovations associated with the diffusion of the Industrial Revolution from England to other societies, which we studied in previous work (Spolaore and Wacziarg, 2009, 2012, 2013). However, a difference between the diffusion of fertility decline and the spread of industrialization is that the two processes started at different frontiers. We argue that the diffusion of fertility decline and the spread of industrialization followed different patterns because societies at different relative distances from the respective innovators (the French and the English) faced different barriers to social learning, imitation, and adoption. Below, we test empirically the hypothesis that barriers to the diffusion of the fertility transition were lower for societies that were culturally closer to the innovators (the French).

Our analysis is related to empirical studies on fertility changes that have emphasized social and cultural effects. Contributions that explicitly consider social influence and social learning in developing countries include studies of the impact of social networks on fertility in Ghana, Kenya and Malawi (Montgomery, Casterline, and Heiland, 1998, Behrman, Kohler, and Watkins, 2002, 2009). Munshi and Myaux (2006) provide an explanation, based on social norms, for why the same external interventions regarding fertility had different effects on different ethnic and religious groups in India. La Ferrara, Chong and Duryea, (2012) estimate the effect of new television-transmitted norms on the fertility behavior of Brazilian women. Manski and Mayshar (2003) explain the complex pattern of fertility across different ethnic-religious groups in Israel through interplay of different private and social incentives, including conformity to group fertility norms. The role of internal migration and social interactions in the diffusion of the fertility transition within France at the end of the 19th century is analyzed in Daudin, Franck and Rapoport (2018).

More broadly, our contribution is connected to the economics literature on social interactions and the spread of new behavior. Our theoretical framework builds on Akerlof (1997), while our approach is also related to Young's (2009) analysis of the diffusion of innovations in models of social influence and social learning, and to Fogli and Veldkamp's (2011) study of the diffusion of female labor force participation in the United States. Discussions of the economics literature on social interactions are provided by Durlauf and Ioannides (2010) and Ioannides (2013), while contributions that link culture and economics are surveyed in Bisin and Verdier (2010), Spolaore and Wacziarg (2013), Spolaore (2014), and Alesina and Giuliano (2015).

To our knowledge, no systematic attempt has been made to quantify cultural barriers across different European regions and to relate them to the diffusion of the fertility transition. This is a central goal of our paper. By bringing in measures of cultural barriers along with economic variables, we aim to bridge the gap between analyses of the demographic transition that emphasize cultural mechanisms and those that focus on economic incentives. We take economic forces into account both in our theory, where we model intrinsic costs and benefits associated with having children, and in the empirical section, where we control for variables such as infant mortality, literacy rates, population density, and urbanization. We find that while economic incentives played a significant role, they are not sufficient to account for the dynamics of the demographic transition in Europe. The novel behavior spread along linguistic lines, pointing to a key role for cultural diffusion. As we will show, we need both culture *and* economics to understand the dramatic decline of fertility over the past two centuries.

2.5 An Example: the Bradlaugh-Besant Trial

We conclude this section with is an historical example that illustrates the diffusion of new social norms about fertility control in the 19^{th} century: The Bradlaugh-Besant Trial.

In 1877 Annie Besant and Charles Bradlaugh challenged the obscenity laws of the United Kingdom by selling a cheap edition of a medical handbook on contraception and family planning. In a Preface to the book, they explained their motives, stating that the "checks that ought to control population are scientific, and it is these which we advocate," and expressing their confidence that "the English public will not permit the authorities to stifle a discussion of the most important social question which can influence a nation's welfare." (reproduced in Chandrasekhar, 1981, pp. 91-2). Besant and Bradlaugh were immediately arrested and charged with violating the Obscene Publication Act of 1857.

The arrest, trial, conviction and eventual acquittal of the two birth-control activists represented a landmark in the history of fertility control in Britain, and brought issues of family planning to the forefront of discussion among the general public (Chandrasekhar, 1981). British birth rates fell significantly in the years right after the trial. Scholars have debated whether the trial may have had a causal effect. For example, Field (1931, p. 244) wrote: "In England particularly... the drop [in fertility] appears suddenly about 1878. The coincidence of this change with the propaganda called forth by the Bradlaugh-Besant trial is too significant to be ignored. The deeper causes of birth restrictions ... were latent in general social conditions... But the ill-starred prosecution gave to slow-gathering forces instant and overwhelming effect." Chandrasekhar (1981, p. 49) also concluded that "the trial ... acted as a catalyst and crystallized public opinion in favor of birth control."

From our perspective, it is important to notice how the spread of fertility control among the general public required major changes in societal norms. People had to perceive fertility control as something ethically and socially acceptable, not as a violation of moral and religious norms. Consistent with our diffusion hypothesis, Besant and Bradlaugh defended themselves by citing French teaching and practices stemming from the weakening of traditional religious beliefs and the emergence of secular values and attitudes. For example, according to the coverage of the appeal in *The Malthusian* (1879), the two activists argued that their arguments "showed how absolutely necessary it was to limit families as the French did," and pointed out that "the Laws of England are still tainted with that spirit of bigotry and intolerance, which has been left as a legacy to us from the times of our barbarous ancestors ....whilst in France it has been found necessary for the confessors of families to abstain from denunciations addressed against conjugal prudence, the misguided jurors of England still prefer starvation and famine to thoughtful and praiseworthy regulation of families."[10]

After Besant and Bradlaugh were acquitted on appeal (on a technicality), social and legal norms changed in Britain, and, in particular, it became legal to use the British mail system to diffuse information about contraception and family planning. Indeed, Beach and Hanlon (2019) find a significant relationship between the public release of information about the Bradlaugh-Besant trial and the reduction of fertility in English speaking countries after 1877. They also find that the effects of the trial impacted regions with widely different economic conditions. As Beach and Hanlon point out (2019, p. 5), "the main debate during the trial, and the vast majority of the literature related to the trial, was not focused on specific contraceptive techniques. Rather, the central debate was over the very idea that couples should have a right, or even a responsibility, to choose their family size." These findings provide further evidence in favor of the spread of new social norms about fertility choice and behavior as a key determinant of the fertility transition during the 19th century.

[10] That is, they related the decline of fertility in France to the rise of secularism and the constraints imposed on the Catholic Church.

3 A Model of Fertility Choice

Motivated by the preceding discussion, we present a model that captures major determinants of fertility choices: intrinsic costs and benefits from having children, social norms about fertility control, and the process of social influence through which norms change and diffuse across different societies. This model generates testable implications regarding the pattern of diffusion of new fertility behavior. Later, we will bring these predictions to the data.

3.1 The Framework

Consider a household i that chooses marital fertility f_i to maximize the following indirect utility:

$$U_i = bf_i - \frac{c}{2}f_i^2 - \sigma(f_n - f_i) \tag{2}$$

where $f_i \leq f_n$. The first two terms capture intrinsic benefits and costs from fertility, such as the utility associated with children and the opportunity costs, in terms of foregone consumption, from raising them.[11] The third term captures the costs of reducing fertility below a maximum "natural" level f_n, the maximum number of children that the household can biologically have when *no* fertility control is adopted. In order to reduce fertility below the natural level, agents must incur costs, measured by the parameter $\sigma > 0$. An interpretation of this parameter is technological - that is, σ is decreasing in the costs of fertility-control technologies (contraceptive devices). At the limit, if fertility controls were completely costless ($\sigma = 0$), the household would just choose the intrinsically optimal level of fertility b/c. A broader interpretation of the parameter σ, which we prefer, is in terms of social and moral norms. In this sense, agents pay a marginal cost σ when they reduce fertility below f_n because of a social and moral stigma associated with using fertility control and achieving a level of fertility below the biological maximum.

The equilibrium choice of fertility is:

$$f^* = \min\{\ \frac{b+\sigma}{c}\ ,\ \ f_n\} \tag{3}$$

It is useful to distinguish between traditional societies, where households choose $f^* = f_n < (b+\sigma)/c$, and modern societies, where households choose $f^* = (b+\sigma)/c < f_n$.

[11] The expression *intrinsic utility* for the first two terms and their reduced-form specification are borrowed from Akerlof (1997). Galor (2011, chapter 4) provides models where fertility choice comes from the trade-off between benefits from having children and costs to raise them. For example, in Galor (2011, p. 120) the optimal number of children is given by the ratio between a parameter capturing the direct utility of children and a parameter capturing the opportunity cost of raising a child as a fraction of the parental unit-time endowment.

Fertility choice can be in one of three possible equilibria, depending on the value of the parameters:

1) *Intrinsically optimal traditional equilibrium*: $f^* = f_n < b/c$ for all $\sigma \geq 0$. In this case, a high natural fertility is intrinsically optimal, and households have no private incentives to reduce their fertility even in the absence of social costs ($\sigma = 0$). When intrinsic benefits from fertility are very high relative to intrinsic costs, social norms that impose additional social costs on low fertility do not reduce households' indirect utility. This can help explain how pro-fertility social norms (high σ) can emerge and survive in equilibrium.

2) *Intrinsically suboptimal traditional equilibrium:* $b/c < f^* = f_n \leq (b + \sigma)/c$. In this case, fertility is above the intrinsic optimum and social norms against fertility control are binding. This equilibrium can hold only if σ is strictly positive and sufficiently large ($\sigma \geq cf_n - b > 0$). In this equilibrium, a reduction in σ does matter for fertility choices, and has a positive effect on indirect utility.

3) *Modern equilibrium:* $f^* = (b + \sigma)/c < f_n$. In this case, fertility is below the natural level f_n. Fertility is at the intrinsic optimum for $\sigma = 0$ and above the intrinsic optimum for $\sigma > 0$. In either case, changes in the intrinsic benefits b and/or costs c are immediately reflected in fertility changes.

This simple model captures both the effects of purely economic factors - such as those that depend on human capital - *and* the effects of social norms. A prediction of the model is that a substantial fall in the net intrinsic benefits of having children relative to their costs may not be sufficient to produce an actual fertility decline unless it is accompanied by a significant change in the social norms about fertility control. The intrinsic benefits and costs can take the driving seat *only* when the social costs have become sufficiently small. This framework can therefore reconcile two conflicting views of fertility decline: the economic view that focuses on intrinsic incentives and the view that stresses social norms. Both sets of forces matter - a fact that is borne by our empirical analysis.

3.2 The Diffusion of the Fertility Decline

Where do social costs σ come from, and how do they change over time? We now extend the model to account for the possibility of social change, from traditional equilibria where $f^* = f_n$ to modern equilibria where $f^* < f_n$. As already mentioned, a reduction in social costs could lead to a shift from a traditional equilibrium to a modern equilibrium only if intrinsic benefits over costs are already low enough. In other words, relatively low intrinsic benefits over costs are a precondition for a switch from a traditional equilibrium to a modern equilibrium, but they may not be sufficient in the absence of a significant reduction in σ. In the rest of the analysis, we only consider societies that are ripe for change - that is, we assume that $b/c < f_n$.

To fix ideas, consider three societies: X, Y and Z, each inhabited by a continuum of households with mass normalized to 1. At time $t < 0$, all households in the three societies are at an intrinsically suboptimal traditional equilibrium, where $b/c < f^* = f_n \leq (b + \sigma_0)/c$. At time 0 the innovator society X experiences a shock to its social norms, so that σ for all its household becomes $\sigma_1 < cf_n - b < \sigma_0$. Consequently, at time 0 society X goes to the new modern equilibrium $f^* = f_m \equiv (b + \sigma_1)/c < f_n$.[12]

3.2.1 The Dynamics of Social Influence

We assume that the change in social norms in society X affects decisions in societies Y and Z through a mechanism of social influence.[13] At each time $t > 0$, each household in society Y and Z considers whether to adopt the new social-norm parameter σ_1 (to imitate the social innovator) or to stick to the old value σ_0. While all households would gain from the switch in terms of intrinsic benefits net of intrinsic costs, each agent is willing to abandon the old social norms only if a sufficiently large number of other households have already adopted the new social norms. Consistent with the literature on social interactions and social distance, we assume that, when deciding whether to conform to the new or to the old social norms, each household in societies Y and Z weighs the influence of other households based on their respective social distance. In general, social distance between two agents captures the extent to which the agents are likely to have socially valuable interactions, and therefore to care about each other's preferences and behavior and to learn from each other. In particular, we assume that the impact of a social innovator on a household depends on what Akerlof (1997, p. 1010) calls *inherited social distance* between the two agents. In our empirical analysis, we measure social distance using linguistic distance between ancestral languages and dialects across different European regions. The relation between dialects and social

[12] For simplicity, we assume that all households in society X experience the shift to the new modern equilibrium simultaneously. The model can be generalized to allow for a gradual diffusion of the new social norms within society X, starting from a subset of innovators, along the lines of the diffusion process from society X to societies Y and Z, discussed next.

[13] For a general discussion of models of social influence and social learning, see Young (2009). For a recent application in the context of female labor force participation, see Fogli and Veldkamp (2011).

distance has been explicitly discussed in the literature on social interactions. For instance, Akerlof (1997, p. 1015) wrote : "the existence of stable dialects for subgroups of a population can only be interpreted as due to the clustering of social interactions. [...] Thus dialects act as a diagnostic for social interaction."[14]

Let $d(i,j) = d(j,i)$ denote the social distance between agent i and agent j. All households within society Y are at a social distance $d(Y,Y) = 0$ from each other and all households within society Z are at a social distance $d(Z,Z) = 0$ from each other. In contrast, each household in society Y is at a distance $d(X,Y) = d(Y,X) > 0$ from each household in society X, while each household in society Z is at a (larger) distance from each household in X : $d(X,Z) = d(Z,X) > d(X,Y)$. Finally, households in societies Y and Z are at distance $d(Y,Z) = d(Z,Y) > 0$ from each other.

At time $t > 0$, a household i in society Y adopts social norms σ_1 if and only if the mass of households that have already adopted these social norms, weighed by their social distance to i, is at least as large as household i's critical threshold μ_i - that is, if and only if:

$$\sum_{k=X,Y,Z} [1 - \beta d(Y,k)] M_{kt-1} \geq \mu_i \tag{4}$$

where M_{kt} denotes the mass of households in society k which have already adopted social norms σ_1 by time $t-1$. By the same token, each household i in society Z adopts the new norms at time t if and only if:

$$\sum_{k=X,Y,Z} [[1 - \beta d(Z,k)] M_{kt-1} \geq \mu_i \tag{5}$$

The parameter β captures the impact of social distance on social influence, where $\beta \leq 1/d(k,j)$ for all $k \neq j$.[15] For simplicity, we assume prohibitive barriers between society Y and Z: $\beta d(Y,Z) \geq 1$.[16]

Households are heterogeneous with respect to their critical thresholds μ_i. Some households are willing to adopt the new social norms as long as those norms have been adopted by a relatively small number of other households, while other households need to observe a much larger mass of modern households before changing their own social attitudes. In each society, critical thresholds

[14] In the Appendix we also use genetic distance, an overall measure of relatedness between populations, as an alternative measure of social distance.

[15] More generally, the conditions could be written as: $\sum_{k=X,Y,Z} \max\{0, [1 - \beta d(Y,k)]\} M_{kt-1} \geq \mu_i$ and $\sum_{k=X,Y,Z} \max\{0, [1 - \beta d(Z,k)]\} M_{kt-1} \geq \mu_i$.

[16] The derivation for the case $\beta d(Y,Z) < 1$ is provided in the Appendix.

$\mu_i's$ are distributed uniformly over the continuum of households, between a minimum threshold $\mu_L \geq 0$ and a maximum threshold $\mu_H > \mu_L$.[17]

We are now ready to derive the dynamics of diffusion of new social norms within and across societies. In order to allow for *any* spread of innovations across societies, we assume that the minimum threshold μ_L is not too high:[18]

$$\mu_L < 1 - \beta d(X,Y) \tag{6}$$

At time 0, only the innovator society has adopted the new social norms, and therefore $M_{X0} = 1$, $M_{Y0} = M_{Z0} = 0$. At time 1, the new social norms are adopted by all households in society Y for whom the social threshold μ_i is smaller or equal to the mass of households who have already adopted the innovation in society X, weighed by their social distance. That is, all households such that:[19]

$$\mu_i \leq [1 - \beta d(X,Y)]M_{X0} = 1 - \beta d(X,Y) \tag{7}$$

At time 1 the new social norms are adopted by the following fraction of households in society Y:

$$M_{Y1} = \min\left\{\frac{1 - \beta d(X,Y)}{\mu_H - \mu_L}, 1\right\} \tag{8}$$

In society Z two cases are possible. For $\mu_L \geq 1 - \beta d(X,Z)$ (relatively high levels of societal conformism and/or high levels of inter-societal barriers), no household adopts the new social innovation at time 1. For $\mu_L < 1 - \beta d(X,Z)$, a positive fraction of households in society Z adopts the new norms; in that case, the mass of households adopting the new norms is:

$$M_{Z1} = \min\left\{\frac{1 - \beta d(X,Z)}{\mu_H - \mu_L}, 1\right\} \tag{9}$$

The number of adopters is lower in society Z than in society Y ($M_{Z1} \leq M_{Y1}$) because of the larger relative social distance from the innovator $d(X,Z) > d(X,Y)$.[20]

[17] For simplicity, we assume that such threshold distributions are identical in society Y and Z.

[18] If $\mu_L \geq 1 - \beta d(X,Y)$, no positive mass of households in society Y (and, a fortiori, in society Z) would ever adopt the new social norms introduced in society X, and the social innovation would never spread across societies.

[19] In order to allow for *any* spread of innovations across societies, we assume that $\mu_L < 1 - \beta d(X,Y)$. In contrast, if we had $\mu_L \geq 1 - \beta d(X,Y)$, societies Y and Z would be so conformist that no positive mass of households in society Y (and, a fortiori, in society Z) would ever adopt the new social norms introduced in society X, and, therefore, the social innovation would never spread across different societies.

[20] The only instance when $M_{Z1} = M_{Y1}$ is in the extreme case when all households in both societies adopt the new social norms immediately, which would occur at very low levels of barriers and/or conformism ($\mu_H \leq 1 - \beta d(X,Z)$).

At time 1, the average level of fertility in society Y is:

$$f_{Y1} = M_{Y1} f_m + (1 - M_{Y1}) f_n \tag{10}$$

and the average level in society Z is:

$$f_{Z1} = M_{Z1} f_m + (1 - M_{Z1}) f_n \tag{11}$$

In general, $f_{Z1} \geq f_{Y1}$, with the highest gap between f_{Z1} and f_{Y1} occurring when $f_{Z1} = f_n$, when $\mu_L \geq 1 - \beta d(X, Z)$. In contrast, there is no gap ($f_{Z1} = f_{Y1}$) in the extreme case $M_{Y1} = M_{Z1} = 1$ ($\mu_H \leq 1 - \beta d(X, Z)$). In the rest of the analysis, we abstract from polar cases, and focus on the intermediate range of parameters in which a positive number of households, but not all households, adopt the novel behavior in society Z at time 1 - that is, the case $\mu_L < 1 - \beta d(X, Z) < \mu_H$.

At time 2, in society Y the new social norms are adopted by all households with critical threshold μ_i such that:

$$\mu_i \leq 1 - \beta d(X, Y) + \frac{1 - \beta d(X, Y)}{\mu_H - \mu_L} \tag{12}$$

which implies the following number of modern households in society Y at time 2:

$$M_{Y2} = \min \left\{ \frac{1}{\mu_H - \mu_L} [1 - \beta d(X, Y) + \frac{1 - \beta d(X, Y)}{\mu_H - \mu_L}], 1 \right\} \tag{13}$$

By the same token, at time 2 in society Z the new social norms are adopted by all households with critical threshold μ_i such that:

$$\mu_i \leq 1 - \beta d(X, Z) + \frac{1 - \beta d(X, Z)}{\mu_H - \mu_L} \tag{14}$$

which implies the following number of modern households in society Z:

$$M_{Z2} = \min \left\{ \frac{1}{\mu_H - \mu_L} [(1 - \beta d(X, Z) + \frac{1 - \beta d(X, Z)}{\mu_H - \mu_L}], 1 \right\} \tag{15}$$

and so on as t increases.

To further simplify notation and without much loss of generality, we assume $\mu_H - \mu_L = 1$. The general levels of M_{Yt} and M_{Zt} at time t can then be written as:

$$M_{kt} = \min\{t[1 - \beta d(X, k)], 1\} \tag{16}$$

where $k = Y, Z$.

3.2.2 Timing of Transition, Fertility Levels, and Social Distances

We can now study the relationship between social distance and the dynamics of the diffusion of novel norms about fertility. Let $M^{\#}$ denote the fraction of modern households such that average fertility is $f^{\#} < f_n$, that is:

$$f^{\#} = M^{\#} f_m + (1 - M^{\#}) f_n \tag{17}$$

Let $T(f^{\#})$ denote the *earliest* time at which such a level $f^{\#}$ is achieved. It is immediate to see that $T(f^{\#})$ occurs earlier for society Y at distance $d(X,Y)$ than for society Z at distance $d(X,Z) > d(X,Y)$:

$$T_Y(f^{\#}) < T_z(f^{\#}) \tag{18}$$

An important special case is when the society has completely transitioned to the new lower level of fertility, i.e. $M^{\#} = 1$ and $f^{\#} = f_m = \frac{b + \sigma_1}{c}$. Abstracting from T having to be an integer, here is the general closed-form solution for the time when a society at social distance $d(k,X)$ reaches $M^{\#}$ with fertility $f^{\#}$:

$$T_k(f^{\#}) = \frac{M^{\#}}{1 - \beta d(k,X)} \tag{19}$$

The time at which a society at distance $d(k,X)$ achieves full modernization ($M^{\#} = 1$ and average fertility equal to f_m) is:

$$T_k(f_m) = \frac{1}{1 - \beta d(k,X)} \tag{20}$$

Therefore, the model delivers a straightforward empirical implication, linking fertility transition time to social distance from the innovator:

Proposition 1: *Societies at a smaller social distance from the social innovator experience an earlier transition to lower fertility*

The model also implies testable predictions about the patterns of the fertility dynamics in different societies in relation to social distance from the innovator. A numerical example will help illustrate these predictions. Assume that $\beta d(X,Y) = 2/3$ and $\beta d(X,Z) = 4/5$. The two societies will experience transitions to lower fertility as detailed in the following table:

Time	M_{Yt}	f_{Yt}	M_{Zt}	f_{Zt}
1	1/3	$\frac{1}{3}f_m + \frac{2}{3}f_n$	1/5	$\frac{1}{5}f_m + \frac{4}{5}f_n$
2	2/3	$\frac{2}{3}f_m + \frac{1}{3}f_n$	2/5	$\frac{2}{5}f_m + \frac{3}{5}f_n$
3	1	f_m	3/5	$\frac{3}{5}f_m + \frac{2}{5}f_n$
4	1	f_m	4/5	$\frac{4}{5}f_m + \frac{1}{5}f_n$
5	1	f_m	1	f_m

In this example, society Y achieves full modernity before society Z, at time 3 rather than at time 5 (empirically, we can interpret each period as a generation). Eventually, both societies transition to the full modern equilibrium where fertility is f_m. Overall, fertility levels are inversely related to distance from the innovator in the earlier phases of the transition to lower fertility. But the relation between fertility and distance from the innovator across societies eventually fades as households in the more distant society catch up and adopt the new social norms.

One way to capture these patterns is in terms of the relation between distance to the innovator and the transition status of each society, which is defined as 0 if the society has not yet achieved full modernity ($f^{\#} < f_m$) and 1 if the society has achieved full modernity ($f^{\#} = f_m$). In the earlier periods (1 and 2), neither Y or Z have transitioned (their transition status is 0), and therefore their relative distance from the innovator has no impact on their relative transition status. In periods 3 and 4, Y has transitioned but Z has not, so that the transition status is negatively related to distance from X. In period 5, both societies Y and Z have transitioned, and therefore the transition status is again independent of distance from the innovator. In summary:

Proposition 2: *The absolute magnitude of the negative relationship between a society's transition status and its distance from the innovator is lower in the earlier phases of the diffusion of the new fertility behavior, becomes higher over time, and falls again in the latest stages of the fertility transition.*

Another useful way to capture the changing relation between fertility patterns and distance from the innovator is in terms of correlations between levels of fertility and distances from the innovator at different points in time. To fix ideas, assume that $f_m = 1$, $f_n = 3$ and $\beta = 1$. Then, at time 1 there is a perfect correlation ($\rho = 1$) between levels of fertility in societies X, Y and Z - which are 1, 7/3, and 13/5, respectively - and relative distances from the innovator, which are $d(X, X) = 0$, $d(X, Y) = 2/3$ and $d(X, Z) = 4/5$. At time 2 the correlation, while still very high, will have decreased to $\rho = 0.95$, as fertility rates in societies Y and Z move, respectively, to 5/3 and 11/5. At times 3 and 4 the correlation between fertility and relative distance goes down to $\rho = 0.63$ as society Y converges to full modern fertility $f_m = 1$ at time 3, while society Z's fertility decreases first to 9/5 at time 3 and then to 7/5 at time 4. Finally, at time 5 there is no longer a positive covariance between fertility levels and distance from the innovator, as all three societies now have the same levels of fertility $f_m = 1$.[21]

[21] A time 5 the correlation between fertility levels and distances is technically undefined because the fertility rate is constant across societies, and therefore its standard deviation is zero. The correlation could be defined, for instance,

The pattern of decreasing correlation between fertility levels and social distance from the innovator is a general feature of the dynamics predicted by our model of social influence. Over time, all societies that are adopting the new norms converge to the same level of fertility f_m, provided that they have similar intrinsic costs and benefits.[22] This can be summarized as follows:

Proposition 3: *In the earlier phases of the diffusion of the fertility decline, there is a strong positive relationship between fertility levels and distance from the innovator, but this relationship becomes weaker as more societies adopt modern social norms over time. Consequently, measured correlations between fertility levels and relative social distance from the innovator are high and positive during the earlier phases of the transition, and decline over time as more societies decrease their fertility levels.*

4 The Diffusion of the Fertility Decline Across Europe

In this section, we bring the main predictions of the model to the data. We test the hypothesis that social distance from the population that experienced the onset of the fertility transition (the French) is related to the diffusion of the fertility decline across Europe, and characterize how this relationship changes over time. In doing so, we take care to control for variables capturing the intrinsic costs and benefits of fertility.

We explore three predictions of the model, corresponding to its three propositions. The first test is to examine whether the fertility transition started earlier in countries at lower social distances from France (Proposition 1). The second test is to examine whether the probability of having experienced the fertility transition was lower for populations or regions at a greater distance from France, and how this relationship changed through time (Proposition 2). The third test is to analyze the determinants of the level of marital fertility (I_g) itself, over time, as a function of social distance from France (Proposition 3). We use two datasets, the main one comprised of 775 sub-national regions of Europe, and the other covering 37 European populations. We focus here on the regional dataset. Both the description of the population-level dataset and the corresponding empirical results appear in the Appendix.

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if we slightly extend the model to allow for some (small) variation in (modern) fertility - that is, if $f_m = 1 + \varepsilon$, where ε is a random variable with zero mean and a very small but positive variance. In that case, the correlation would be defined, and equal to 0, at time 5.

[22] For any pair of societies Y and Z such that $d(Y,X) < d(Z,X) << 1/\beta$ there will be a time T^e such that $f_{Yt} < f_{Zt}$ for $t < T^{e,}$, but $f_{Yt} = f_{Zt}$ for $t \geq T^e$.

4.1 Data and Measurement

The database of marital fertility rates in PEFP includes detailed information on various measures of fertility across 775 regions of 25 European countries, from 1831 to 1970. The regional dataset was built starting from this initial set of regions. In constructing the regional dataset, we faced several challenges described in what follows.

Measuring social distance. We require a summary measure of social distance from each region to the innovator (France) - i.e. our main explanatory variable. To proxy for social distance, we use linguistic distance. Linguistic distance captures separation times between populations speaking different languages. Indeed, languages are transmitted from parents to children and linguistic innovations arise in a regular fashion. Thus, populations at greater linguistic distances are likely to be also distant from each other along a wide range of other cultural dimensions. In Spolaore and Wacziarg (2016), we showed that linguistic distance is positively associated with genealogical separation times and with cultural differences across countries. It is important not to interpret the effect of linguistic distance narrowly as reflecting only the ability to communicate, but to interpret it more broadly as a general indicator of cultural distance: the barriers captured by linguistic distance include communication, trust, differences in norms, values and attitudes, i.e. ancestral distance more generally.

To construct a measure of linguistic distance across the regions of Europe, we painstakingly constructed a database of ancestral European languages and dialects at a disaggregated geographic level corresponding to the regional boundaries in the fertility data. Using a detailed map of the ancestral languages and dialects of Europe (including extinct dialects), delineating the areas where these were spoken in the 18^{th} and 19^{th} centuries, we matched every language in the source map to a subnational region in the fertility dataset from Coale and Watkins (1986).[23] We ended up with 275 languages and dialects matched as primary languages of each of the 775 regions.[24] It is important to

[23] The source for the language data was the map provided at http://www.muturzikin.com/carteeurope.htm. To our knowledge this is the most comprehensive and detailed maps of historical European languages. Moreover language headings used in this map closely track those in Ethnologue, on which we rely to derive linguistic distance.

[24] In a minority of cases where a region straddles two linguistic areas we matched the region to two languages - a primary and a secondary one. 108 of the 775 regions are matched to a secondary language. In most of the case the match was to a language that is otherwise the primary language of some region, but for 26 regions the secondary language is unique to that region. For instance, Kerneveg (a sub-dialect of Breton) is nowhere the primary language but is matched as the secondary language of 3 subdivisions of Brittany (each of which is matched to a different

note that these languages are no longer necessarily spoken in the corresponding regions, as the 19^{th} and 20^{th} centuries saw the virtual elimination of many subnational dialects in several European countries through nation building (Alesina and Reich, 2013). For instance, regions of Southern France are variously matched to Langue d'Oc, Provençal, or Savoyard, spoken nowadays by very few. Linguistic distance based on 18th and 19th century languages is more likely to capture barriers relevant during the time of the European fertility transition, and to capture a broad range of cultural differences with deep roots. Next, for each ancestral language we found its linguistic classification from Ethnologue.[25] This allowed us to calculate the linguistic distance of each language to any other (our main focus will be distance to French, i.e. the version of Langue d'Oïl spoken around Paris, and English) by counting the number of different linguistic nodes separating any pair of languages.[26] Thus, we obtained a series describing the linguistic distance of each region in our regional dataset to French and to English. The series on the number of different linguistic nodes to French ("Français") ranges from 1 to 10, with a mean of 7.5. This is the main variable used to assess the role of social distance to the birthplace of the fertility transition, as a determinant of its diffusion to the rest of Europe.

Geographic barriers. We also assembled a comprehensive database of geographic characteristics for each of the 775 regions. We determined the coordinates of the centroid of each region, and calculated their geodesic, longitudinal and latitudinal distance to France and England. We also coded variables representing natural barriers: whether a region is on an island, whether a region is landlocked, whether it shares a sea or ocean with France, whether it is contiguous to France and whether a region is separated from France by a mountain range (the Alps and the Pyrenees). These serve to construct the geographic controls included in the regressions that follow.

sub-dialect of Breton as primary language). We only made use of the primary language in our analysis. A region's secondary language is usually very closely related to its primary language, as the example of the regions of Brittany suggests.

[25] For instance, French (Français) is classified as follows: Indo-European - Italic - Romance - Italo-Western - Western - Gallo-Iberian - Gallo-Romance - Gallo-Rhaetian - Oïl - Français.

[26] For instance, the linguistic classification of Italian is Indo-European - Italic - Romance - Italo-Western - Italo-Dalmatian. Thus, Italian shares 4 nodes in common with French out of a possible 10 nodes, and it's linguistic distance to French is equal to 6. See Fearon (2003), p. 211, and Desmet et al. (2012) for work using the structure of linguistic trees to measure linguisitic distance.

Intrinsic determinants of fertility. We assembled as much data as we could obtain related to the intrinsic costs and benefits of fertility choices, at the regional level. First, we used regional infant mortality data from PEFP. This variable varies through time, but is only available for about 300 regions. Second, we gathered data at the region level on urbanization rates in 1800 and 1850, population density in the mid-19th century, and literacy rates in 1880. Due to data availability constraints, these data cover many, but not all 775 regions for which marital fertility data is available. The Appendix describes the sources and coverage of these data in greater detail.

Border changes. During the period under scrutiny, the borders of some European countries changed, so that a region that was located in one country at one point in time may have become part of another later on. For example, this is the case for many regions of Poland, variously in Germany or Russia at different times in the sample period. In our sample of 775 regions, 83 regions in 1946 are in different countries than in 1846. These changes are mostly (but not exclusively) the result of border redrawings that occurred after the First and Second World Wars. In the source data on fertility from PEFP, these regions are alternately included in one country or another, sometimes with different region names and borders. We redefined a single identifier for each region, with consistent borders throughout, and separately coded the country to which each region belongs at different points in time, at 20-year intervals between 1846 and 1946. Country fixed effects can then be defined using country borders at different points in time.

Time periods. We need to define the temporal unit of analysis. While the right-hand side variables are time invariant, the rate of marital fertility I_g as provided by PEFP is an unbalanced panel. Some countries like France have vast amounts of data through time. Others, chiefly in Eastern Europe, have fewer years of data available in the interval 1831 to 1970. To ensure that enough observations on I_g are available in any period, we defined 12 overlapping periods of 30 years centered at 10-year intervals, so that period 1 is 1831 to 1860, period 2 is 1841 to 1870, etc.[27] The analysis of the determinants of I_g will be conducted on repeated cross-sections defined over these 30-year periods, with marital fertility averaged over all available years within these periods. This issue does not arise when exploring the determinants of the marital fertility transition date, or of the fertility transition status at each point in time, both of which are available for almost all of the

[27] For the first period data was available only for 184 regions from 5 countries (as defined by their 1946 borders). By period 3 we have 531 regions from 20 countries, and by 1911-1940 (period 9) we have 766 regions from 25 countries, i.e. most of the regions in the sample have available data on marital fertility in the early decades of the 20^{th} century.

775 regions.

Fertility Transition Dates and Transition Status. In addition to raw data on marital fertility (I_g), PEFP provides estimated transition dates at the regional level at 10-year intervals in map form (Map 2.1 annexed to Coale and Watkins, 1986 and reproduced here as Figure 1). These dates represents the first instance when a 10% decline in I_g is detected for a population (so, for instance, if for a given population the first recorded level of I_g is 0.70, the transition date is the first date for which I_g falls below 0.63). For each region, starting from a visual examination of the PEFP map, we assigned a fertility transition date (FTD) equal to the midpoint of each 10-year interval. Looking at the numeric data on I_g, we verified that these dates indeed correspond to the earliest 10% decline in marital fertility. For transition dates before 1830 and after 1930, we referred directly to the data on I_g to determine the date of a 10% decline in the index of marital fertility. We ended up with data for 771 regions, from 25 European countries.[28] At any date t, the fertility transition status T_t is then defined as 1 if $t \geq FTD$, and 0 otherwise.

4.2 Specification and Results

This subsection presents empirical results obtained from the analysis of the regional dataset. Summary statistics for the regional dataset are presented in Table 3. There, we see the marital fertility transition at work: the average level of I_g declines from 0.623 in 1831-1860 to 0.336 in the 1951-1970 period. Across regions, the average date of the transition is 1899, with a standard deviation of about 25 years. Turning to correlations in Panel B of Table 3, we see that the fertility transition date is positively correlated with linguistic distance to French ($\rho = 0.52$). Similarly, the level of marital fertility (I_g) is highly correlated with linguistic distance to France in early periods, but this correlation declines in later periods as more and more regions undergo the transition, consistent with our diffusion model.

4.2.1 Determinants of the Transition Date

Our first specification seeks to explain the transition date, as a test of Proposition 1:

$$FTD_{jc} = \delta_1 LD^f_{jc} + X'_{jc}\delta_2 + \alpha_c + \varepsilon_{jc} \tag{21}$$

where FTD_{jc} is the marital fertility transition date in region j of country c, LD^f_{jc} is the linguistic distance of region j to French, α_c is a country fixed effect and $X_{jc}$is a vector of control variables.

[28] 4 regions in the Balkans did not have enough I_g data to ascertain a date and were not coded on the source map.

The inclusion of country fixed effects is meant to control for any country-specific time invariant characteristics, such as national institutions and policies, that could be correlated with both the timing of the transition and social distance from France. Country borders used to define the country dummies are obtained from 1846 borders, but it matters little for our results whether countries are defined by later borders. The vector X_{jc} varies across specifications. It contains measures of geographic barriers between region j and France as well as proxies for the intrinsic costs and benefits of fertility choices, such as the urbanization rate, population density (a proxy for technological advancement in Malthusian times) and the literacy rate.

Table 2 presents the baseline results considering distance to the French language (for linguistic distance) and to Paris (for geographic distance).[29] We find a positive and highly significant effect of linguistic distance to the French language on the marital fertility transition date - whether or not we control for geographic distance. In the specification of column 2, with the broadest set of geographic controls, we find a standardized effect of linguistic distance equal to about 26.78%.[30] The effect is highly significant statistically. The regression overall performs well in accounting for variation in transition dates, with an overall R^2 of 72% (dropping the country dummies, the R^2 only falls to 60%). This alleviates concerns that transition dates may be estimated with too much error to allow for meaningful estimates of their determinants. Both the R^2 and the coefficient on linguistic distance to French remain very stable across specifications as we add controls, alleviating concerns that there may be an important omitted variable (Oster, 2017). Finally, the effect of linguistic distance to French remains robust when we include controls for population density, urbanization and literacy. These variables take on negative signs, as expected, since more urbanized, denser and more literate regions face a lower ratio of intrinsic benefits to costs of children.

Table 3 runs a horserace between distance to English/London and distance to French/Paris, again with country fixed-effects. The goal is to see whether the fertility transition followed a diffusion process that was distinct from that of the Industrial Revolution, for which the innovation frontier was England. To do so, we include linguistic distance to English and geographic distance to London in the specification of equation (21). We find that, no matter the included set of control

[29] More precisely, linguistic distance is to the version of Langue d'Oïl spoken in the region around Paris. There is substantial linguistic variation within France when considering its old regional dialects, as we do.

[30] In what follows, magnitudes are assessed using the standardized beta coefficient on the variable of interest: the effect of a one standard deviation change in the independent variable expressed as a share of a one standard deviation change in the dependent variable.

variables, the effect of linguistic distance to French on the transition date is positive, significant, and its standardized magnitude varies between 25% and 40%. In contrast, the effect of linguistic distance to English is often statistically insignificant and is always small in magnitude. These inferences hold even in column (4), where we control for variables capturing the intrinsic costs and benefits of fertility choice, where linguistic distance from English bears a negative and insignificant coefficient. In sum, linguistic distance to French wins in a horserace with linguistic distance to English, indicating that the diffusion process stemmed from France not England.[31] This result casts doubt on the view that the marital fertility transition was primarily a by-product of industrialization. These results are particularly noteworthy in light of the inclusion of country fixed effects, a stringent test of our hypothesis since it requires identification from within-country, cross-regional variation.[32]

Finally we replicated the same horserace, but between distance to German/Berlin and distance to French/ Paris. This is to assess if perhaps the new fertility behavior might have diffused from Germany (for instance because that country was a leader in terms of literacy and human capital). The results appear in Appendix Table A17. We find that the effect of linguistic distance to France is always positive and significant, while the effect of linguistic distance from German is statistically insignificant, and of the wrong sign.

[31] Basso and Cuberes (2012) find a positive effect of genetic distance from the UK on the fertility transition date in a worldwide sample of countries. However, in this broader sample, much of the variation in genetic distance comes from the distance between non-European and European populations, trumping variation between Europeans. This fact opens up the possibility that the frontier for fertility limitations was not the English but another European population. We show that this population was in fact the first adopter of the new fertility behavior, France, where economic modernization came late relative to the UK, the birthplace of the modern Industrial Revolution. Hence, in contrast with the conclusions in Basso and Cuberes (2012), our results suggest that economic development was not the sole or principal force in the spread of fertility limitations in Europe, but that a process of cultural and social diffusion from France was an important force.

[32] Appendix Tables A3, A4, A5 and A7 show empirical estimates of the effect of social distance from France on the fertility transition date in the population-level dataset. Tables A3, A4 and A5 use genetic distance from France as a measure of social distance, while Table A7 uses two measures of linguistic distance for this purpose. We find results substantively similar to those obtained here using the regional dataset. The Appendix describes these results in detail.

4.2.2 Determinants of Transition Status

We now seek to better understand the dynamics of the fertility transition, testing Proposition 2. As defined above, T_{jct} is a simple dichotomous indicator of a region's fertility transition status. For each date t separately, we run probit regression of this indicator on linguistic distance to France and a set of geographic controls:

$$T_{jct} = \gamma_0 + \gamma_1 LD^f_{jc} + X'_{jc}\gamma_2 + \varepsilon_{jct} \tag{22}$$

The analysis of the transition status has two limitations: 1) We no longer include country fixed effects: since at a given date all or none the regions of some countries have $T_{jct} = 1$, the corresponding country dummy perfectly determines the outcome, resulting in far fewer observations from which to estimate the within country-effects of the other covariates.[33] 2) We include a smaller set of covariates, excluding the geographic dummy variables but maintaining the geographic distance measures. The reason is the same as the preceding: for some periods, some dummy variables perfectly predict the outcome, and the corresponding observations must be dropped, resulting in small samples. Since we wish to compare the magnitude of the effect of linguistic distance across various periods, we require the sample and the set of controls to be the same across time.

We start by displaying graphically the cumulative share of regions, among the 771 for which transition date data is available, for which T_{jct} takes on a value of 1 (Figure 2). The process follows a logistic distribution. The earliest transition dates signalling the first 10% decline in I_g are in 46 French regions; regions with the latest dates are located mostly in Ireland and Spain in the late 1920s, 1930s and early 1940s. The last regions to begin the marital fertility transition in this dataset are Salamanca (1941), Zamora (1941), Avila (1942), Dublin County (1943) and Las Palmas/Canary Islands (1945).

The logistic pattern provides information about the nature of the diffusion process. Young (2009) considers four possible processes: pure inertia (agents adopt with exogenous delays, without feedback from prior to future adopters), contagion (agents adopt when they come in contact with prior adopters, and innovations spread like epidemics), social influence (agents adopt when enough

[33] When including country fixed effects in the probit specifications anyway, we end up with as few as 89 observations (for 1841) and as many as 204 (in 1901) from which to estimate the relationship - in all cases a far cry from the 771 observations used in Table 4. There are too few observations to obtain estimates for the 1921 cross-section. Despite the very small samples, the effect of linguistic distance from France is negative for all periods where enough data is available, even with country fixed effects.

other people in their reference group have adopted, as in our theoretical model), and social learning (agents adopt once they see enough evidence from prior adopters' outcomes to convince them that the innovation is worth adopting). A process that is driven only by inertia decelerates the whole time, implying that the adoption curve should be strictly concave (Young, 2009, p. 1901). Thus, pure inertia cannot explain the logistic curve that characterizes the adoption of modern fertility behavior.

Unlike a process that is due to pure inertia, contagion accelerates initially and then decelerates. However, a process that is driven only by contagion cannot accelerate beyond the fifty percent adoption level, and the hazard rate (the rate at which non-adopters become adopters) must be non-increasing relative to the number of adopters (Young, 2009, p. 1901). In our curve, the hazard rate is not uniformly decreasing relative to the number of adopters, but increases over some intervals. Therefore, the adoption process cannot be explained by pure contagion either. Instead, the observed pattern of adoption is consistent with a diffusion process in which the new fertility behavior is gradually adopted by different agents through mechanisms of social influence (consistent with our theoretical framework) and/or social learning.

Results from estimating equation (22) using probit are presented in Table 4, at 20 year-intervals from 1841 to 1941, a period that covers the bulk of the transition period. Table 4 reveals an initially insignificant effect of linguistic distance to French on the fertility transition status. The effect becomes significantly negative in 1861, and its standardized magnitude rises to 52% in 1881, before declining thereafter and becoming insignificant in 1941.[34] This corresponds to the prediction of Proposition 2. We find a similar pattern when controlling for the literacy rate, the urbanization rate, and population density (Appendix Table A8), despite a much smaller sample of only 298 regions from 8 countries.

For a more complete view of the dynamics of the transition, Figure 3 displays graphically the time path of the standardized effect of distance from French, estimated at every date between 1831 and 1941 for which a transition occurs in some regions. The pattern in this figure is consistent with Proposition 2: At the beginning of the period, only regions in France have transitioned. The effect of linguistic distance from French on the probability of having begun the transition is therefore essentially zero. As we enter the diffusion period, the effect of linguistic distance from French progressively becomes strongly negative (i.e. being linguistically distant is associated with

[34] Here, our measure of standardized magnitude is the probit marginal effect of linguistic distance to French, multiplied by the standard deviation of linguistic distance, and divided by the sample mean of transition status.

a lower probability of starting the marital fertility transition), with the standardized effect peaking at −61.45% in 1891. As more and more regions at greater distances from France begin their transitions, the effect then goes back to zero. The U-shaped time profile of the effect of linguistic distance on the probability of experiencing the onset of the marital fertility transition is therefore evidence of a diffusion process that works in large measure through social distance.

4.2.3 Determinants of I_g

The last step in our analysis of the dynamics of the fertility transition is to estimate directly the determinants of the level of marital fertility (I_g), i.e. testing Proposition 3. We can once again control for country fixed effects, the full set of geographic controls, and proxies for the intrinsic costs and benefits of fertility choices. I_g is also a continuous rather than a dichotomous indicator, so we avoid the arbitrariness of having to define a transition as the earliest occurrence of a 10% drop in I_g. The specification is:

$$Ig_{jc\tau} = \eta_1 LD^f_{jc} + X'_{jc}\eta_2 + \alpha_c + \varepsilon_{jc\tau} \quad (23)$$

where Ig_{jct} is the PEFP marital fertility index in region j of country c in period τ. The regression is run on separate cross-sections of regions for each 30-year period indexed by τ.[35]

Estimation results are presented in Table 5 for all odd-numbered time periods, including the full set of geographic controls. We find a large, positive and statistically significant effect of linguistic distance to France on the level of I_g, throughout the sample period. Moreover, focusing on a common sample of 630 regions to facilitate a comparison of the effect through time, the last row of Table 5 displays the standardized magnitude of the effect of linguistic distance to French going back to Period 5 (1871-1900): the effect declines as more and more regions at progressively greater linguistic distances from France adopt new fertility behavior, consistent with Proposition 3.[36]

[35] Appendix Tables A6 and A7 show the corresponding empirical estimates of the determinants of I_g, obtained from the population-level dataset, using genetic distance to France and linguistic distance to French, respectively, as measures of social distance. We find substantively similar results to those obtained from the regional dataset. The Appendix describes these results in detail.

[36] In Appendix Table A9, we augment the specification of equation (23) by adding the minimum linguistic distance to regions that have already made the fertility transition. Table A9 reveals that the effect of linguistic distance to French on the level of I_g in various periods remains positive, statistically significant and large in magnitude. The effect of minimum linguistic distance to regions that have already made the transition, while positive and sometimes statistically significant (in Periods 5 and 9), is much smaller in terms of standardized magnitude than linguistic

Figure 4 displays the same effect through time for a smaller set of 519 regions, estimated from the same specification (equation (23)), for Periods 4-12.[37] The standardized effect is slower to decay to zero than in the probit regressions of the preceding subsection, which explored the determinants of the beginning of the fertility transition. Reductions in I_g continued after that. Hence, countries keep converging to the frontier's fertility behavior past their transition dates, and linguistic distance to French continues to predict how far these regions are from the frontier even in the 1931-1960 period.

In Table 6, we augment the specification of equation (23) by including four additional controls for infant mortality (time varying), population density (mid-19th century), the urbanization rate (in 1850) and the literacy rate (in 1880). We focus on Period 5 (1871-1900), when the diffusion of the fertility decline was in full swing.[38] This is also a period relatively close to the time when urbanization, population density and literacy are measured. We find a significant role for these proxies for the intrinsic costs and benefits of fertility choices. In column (1), infant mortality enters with the expected positive sign: regions with higher infant mortality have higher total fertility (Preston, 1978, Doepke, 2005). In column (2), we see that higher population density is associated with lower fertility, as would be expected if population density is a proxy for technological advancement. In column (3), a similar result is obtained for more urbanized regions. In column (4) we find a negative and significant effect of the literacy rate on marital fertility, echoing the significant negative effect of human capital on fertility often documented in the literature (Galor, 2011, chapter 4). Columns (5) and (6) include several or all of these additional controls together. The sample is reduced, yet the effect of linguistic distance to French continues to remain significant and large in magnitude.

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distance to France. This result is consistent with the extension to our theory, also shown in the Appendix, where regions can be influenced by both the innovation frontier (France) and by other regions that experienced the fertility transition.

[37] We display estimates for these 9 periods only because we again require a balanced sample of regions to meaningfully compare magnitudes across time, and early periods contain less data on I_g.

[38] Appendix Tables A10 through A16 each replicate each column of Table 6 for all odd-numbered time periods. All these show a declining standardized effect of linguistic distance from French on the marital fertility index as time goes by, even in demanding specifications where all controls are introduced at once and, as a result, only a small share of the original sample of regions remains (for example, see Table A15). The effects of infant mortality, urbanization, density and literacy themselves are generally quite stable across time periods, especially when considering Periods 3-11 which have more available regional data than Period 1.

In Table 7, we test whether the four proxies for the intrinsic costs and benefits of fertility choices diffused from France. The specification is similar to that in (23), but the dependent variable is now infant mortality, population density, urbanization and literacy. The specifications are single cross-sections of regions, with country fixed-effects and geographic controls. We find some evidence that linguistic distance to French is positively correlated with infant mortality, with a modest magnitude. But we find no effects of linguistic distance from French on levels of population density, urbanization and literacy. Thus, there is little evidence that these fertility-reducing variables diffused from France (of course, they may have diffused from another frontier). In sum, the variables capturing the intrinsic costs and benefits of fertility choices have effects independent from that of the diffusion of new fertility norms from France.

In Table 8, we include all the geographic and linguistic distance variables not only relative to France / French but also relative to England / English, to conduct a horserace. In all periods, the effect of linguistic distance to French is much larger in magnitude than that of linguistic distance to English. For instance, in Period 5, when the diffusion process was in full-swing, the standardized effect of distance from French on I_g is 51.3% while the effect of linguistic distance from English is 5.7% and is statistically indistinguishable from zero. These results confirm those obtained in Table 3 when explaining the transition date. We find little evidence that the fertility transition diffused from the English rather than the French, and that it was therefore a by-product of the Industrial Revolution. Instead, it was partly the result of a different cultural diffusion process, starting from France.[39]

We conducted additional robustness tests. First, we replicated Tables 5 and 6 controlling for the log of geodesic distance rather than its level (Appendix Tables A19 and A20). This did not effect the results. Second, we replicated Tables 5 and 6, but removing the country fixed effects, to assess the extent to which time invariant, country-specific factors matter for our results (Appendix Tables A21 and A22). Without fixed effects, the magnitude of the effect of linguistic distance to French is not materially affected - it continues to be positive, significant and large: within-country variation is sufficient to establish our effect, and it is not the case that the inclusion of country fixed-effects results in the loss of much relevant variation.

[39] In Appendix Table A18, we conduct a similar horserace with German / Berlin. We again find that linguistic distance to French has a more statistically significant and quantitatively larger effect on marital fertility levels at various dates (when magnitude is properly assessed using the standardized beta coefficient).

5 Conclusion

To understand the fertility decline in Europe, we need to consider both cultural and economic forces. This paper reconciles an economic approach to fertility decisions with a central role for the diffusion of new social norms along cultural lines.

In our model, the transition from higher traditional fertility to lower modern fertility is the outcome of a process of social innovation and social influence, whereby the process of adoption of the novel behaviors and norms depends on the social distance between early adopters and late adopters. In our empirical analysis, we studied the determinants of marital fertility in a sample of European populations and regions from 1831 to 1970, and tested the theoretical model using a novel data set of ancestral linguistic distances between European regions. We found that social distance from the innovator (France) is positively related with fertility transition date across populations and regions, and positively related to the level of marital fertility in different periods. Moreover, the dynamics of the fertility transition match the predictions of the model: the impact of linguistic distance to French on fertility is higher early and at the peak of the transition period, but fades as more and more regions adopt the modern behavior.

The diffusion of the fertility decline and the spread of industrialization followed different patterns because societies at different relative distances from the respective innovators - the French and the English - faced different barriers to imitation and adoption, and barriers were lower for societies that were culturally and linguistically closer to the innovators. Eventually, all the regions in our sample transitioned to lower fertility, which suggests that cultural distance from French does not capture the direct effect of persistent French cultural traits, but the effect of barriers to the cultural diffusion of new fertility norms.[40] Indeed, this paper provides evidence that the spread of new behaviors and norms across cultural barriers was an important force behind the decline of fertility in Europe.

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[40] Similar results, which we interpret again in terms of cultural barriers, are obtained for the effect of genetic distance, presented in the Appendix.

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Table 1 - Summary Statistics for the Regional Dataset

Panel A. Means and Standard Deviations for the Main Variables of Interest

Variable	# Obs	Mean	Std. Dev.	Min	Max
Marital Fertility Transition date	771	1899.096	24.989	1830	1945
Difference in linguistic nodes to Français	775	7.495	2.827	1	10
Geodesic distance to Paris (km)	775	1109.641	714.633	0.000	3977.143
Ig (1831-1860)	184	0.623	0.136	0.321	0.972
Ig (1861-1890)	609	0.664	0.123	0.271	1.001
Ig (1891-1920)	675	0.594	0.129	0.225	0.914
Ig (1921-1950)	766	0.421	0.121	0.086	0.763
Ig (1950-1970)	706	0.336	0.097	0.129	0.714

Panel B. Simple Correlations among the Main Variables of Interest

	Ig 1831-1860	Ig 1861-1890	Ig 1891-1920	Ig 1921-1950	Ig 1950-1970	Marital Fertility Transition date	Difference in linguistic nodes to Français
Difference in linguistic nodes to Français	0.729	0.514	0.511	0.197	-0.080	0.521	1
Geodesic distance to Paris (km)	0.366	0.089	0.399	0.491	-0.042	0.541	0.373
# of obs.	184	609	675	766	706	771	775

Note: There are 4 regions with Ig data but no fertility transition dates. These regions, in the Balkans, have too little data to ascertain when the transition occurred. These regions are Bosnia and Herzegovina, Kosovo in Serbia, Podrinje (a small region of Bosnia) and Zetska (Montenegro).

Table 2 - Cross-Regional Regressions for the Marital Fertility Transition Date, with Country Fixed-Effects
(Dependent variable: Marital Fertility Transition Date)

	(1)	(2)	(3)	(4)	(5)	(6)
	Univariate	**Control for geography**	**Control for literacy**	**Control for pop. density**	**Control for urbanization**	**Control for all**
# of different nodes with Français	**2.409** **(5.30)***	**2.363** **(5.11)***	**3.394** **(8.26)***	**2.593** **(3.51)***	**2.572** **(3.45)***	**4.050** **(5.69)***
Geodesic distance to Paris, km		0.001 (0.16)	-0.026 (1.58)	-0.006 (0.72)	-0.009 (0.97)	-0.037 (1.99)**
Literacy rate, 1880			-0.057 (0.93)			-0.057 (0.67)
Population density, mid-19th century				-0.101 (3.09)***		-0.002 (0.05)
Urbanization rate, 1850					-12.516 (3.11)***	-11.264 (1.75)*
Constant	1,889.677 (408.72)***	1,872.125 (345.88)***	1,871.509 (209.30)***	1,870.138 (212.02)***	1,870.523 (192.46)***	1,861.349 (159.43)***
R^2	0.70	0.72	0.74	0.72	0.74	0.76
# of regions (# of countries, 1846 borders)	771 (25)	771 (25)	413 (9)	556 (20)	441 (21)	298 (7)
Standardized Beta (%)	27.298	26.775	38.748	27.682	27.335	41.922

Notes:

- Robust t-statistics in parentheses: * p<0.1; ** p<0.05; *** p<0.01.
- Country fixed-effects are defined as per 1846 borders.
- Columns (2)-(6) all include additional controls for: Absolute difference in longitudes to Paris, absolute difference in latitudes to Paris, dummy=1 if region is barred by a mountain range from France, dummy =1 if region is contiguous with France, dummy =1 if region shares at least one sea or ocean with France, dummy =1 if region is landlocked, dummy =1 if region is on an island.

Table 3 - Cross-Regional Regressions, English-French Horserace, with Country Fixed-Effects (Dependent variable: Marital Fertility Transition Date)

	(1)	(2)	(3)	(4)
	Control only for geodesic distance	**Control for all distances**	**Control for micro-geography**	**Control for literacy, density, urbanization**
# of different nodes with Français	2.234 (4.87)***	2.274 (4.96)***	2.410 (5.21)***	3.934 (5.49)***
# of different nodes with English	1.354 (1.75)*	1.336 (1.67)*	1.847 (2.26)**	-0.341 (0.20)
Geodesic distance to London, km	-0.025 (2.01)**	-0.043 (2.58)**	-0.050 (2.90)***	-0.078 (2.70)***
Geodesic distance to Paris, km	0.033 (2.94)***	0.043 (2.41)**	0.053 (2.84)***	0.028 (0.70)
Literacy rate, 1880				-0.086 (1.07)
Population density, mid-19th century				0.022 (0.53)
Urbanization rate, 1850				-12.212 (1.93)*
Constant	1,884.775 (285.71)***	1,882.509 (268.31)***	1,871.968 (266.92)***	1,867.674 (126.10)***
R^2	0.72	0.72	0.72	0.77
N	771	771	771	298
Standardized Beta, France (%)	25.321	25.771	27.305	40.715
Standardized Beta, England (%)	6.558	6.472	8.944	-1.348

Notes:

- Robust t-statistics in parentheses: * p<0.1; ** p<0.05; *** p<0.01
- Country fixed-effects are defined as per 1846 borders.
- Column (2) includes controls for: absolute difference in longitudes to London, absolute difference in latitudes to London, absolute difference in longitudes to Paris, absolute difference in latitudes to Paris.
- Columns (3) and (4) include all the controls in column (2) plus: dummy for contiguity to England, dummy for regions that share at least one sea or ocean with England, dummy for contiguity to France, dummy for regions that share at least one sea or ocean with France, dummy for regions barred by a mountain range to France, dummy for landlocked region, dummy for regions located on an island.
- The broadest sample of 771 regions pertains to the regions of the following 25 countries: Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, England and Wales, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Spain, Sweden, Switzerland, Yugoslavia.

Table 4 - Probit Regressions for Fertility Transition
(Dependent variable: fertility transition status indicator)

	(1)	(2)	(3)	(4)	(5)	(6)
	1841	**1861**	**1881**	**1901**	**1921**	**1941**
# of different nodes with Français	**-0.00002**	**-0.008**	**-0.025**	**-0.022**	**0.019**	**0.001**
	(0.93)	**(2.76)*****	**(5.44)*****	**(2.86)*****	**(3.87)*****	**(1.07)**
Geodesic distance to Paris, 1000 km	0.0001	0.079	-0.048	-1.036	0.197	0.004
	(0.33)	(1.95)*	(0.46)	(4.80)***	(1.93)*	(0.42)
Absolute difference in longitudes, to Paris	-0.032	-6.623	-1.823	27.183	-22.857	-0.120
	(0.83)	(2.55)**	(0.28)	(2.05)**	(3.51)***	(0.24)
Absolute difference in latitudes, to Paris	-0.016	-9.104	-11.418	48.128	-30.036	-0.969
	(0.40)	(2.42)**	(1.43)	(3.02)***	(4.26)***	(1.22)
Pseudo R^2	0.61	0.47	0.41	0.32	0.21	0.18
Standardized Effect of linguistic distance to Français (%)	-0.077	-26.495	-52.331	-16.097	6.549	0.204

Notes:

- t-statistics in parentheses: * p<0.1; ** p<0.05; *** p<0.01
- The dependent variable for year t is defined as 1 is a region has undergone the fertility transition by year t (defined as having attained a 10% decline in I_g by date t, as in Coale and Watkins, 1986), zero otherwise.
- The table reports probit marginal effect. The standardized effect is equal to the probit marginal effect multiplied by the standard deviation of linguistic distance to Français, divided by the mean of the dependent variable.
- Regressions are based on a balanced sample of 771 regions from 25 countries: Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, England and Wales, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Spain, Sweden, Switzerland, Yugoslavia.

Table 5 - Cross-Regional Regressions for Ig through Time, with Country Fixed-Effects
(Dependent variable: Index of Marital Fertility, Ig)

	(1)	(2)	(3)	(4)	(5)	(6)
	Period 1 (1831-1860)	**Period 3 (1851-1880)**	**Period 5 (1871-1900)**	**Period 7 (1891-1920)**	**Period 9 (1911-1940)**	**Period 11 (1931-1960)**
# of different nodes with Français	**16.299** **(4.24)*****	**23.346** **(12.53)*****	**22.183** **(11.57)*****	**20.105** **(9.66)*****	**12.858** **(6.68)*****	**7.601** **(4.74)*****
Geodesic distance to Paris, km	0.142 (0.55)	0.068 (1.02)	0.006 (0.10)	0.018 (0.28)	-0.008 (0.25)	-0.022 (0.77)
Constant	578.165 (5.46)***	494.478 (12.08)***	468.778 (11.66)***	375.595 (8.78)***	55.956 (1.04)	191.099 (4.59)***
R-squared	0.69	0.69	0.61	0.59	0.65	0.64
# of regions (# of countries, 1946 borders)	184 (5)	531 (20)	659 (24)	675 (25)	766 (25)	748 (24)
Standardized Beta on linguistic distance from Français (%)	41.074	54.865	49.900	43.141	26.431	18.354
Standardized Beta (%), common sample of 630 regions (*)	-	-	49.548	43.218	26.978	17.980

Notes:

- t-statistics in parentheses: * $p<0.1$; ** $p<0.05$; *** $p<0.01$
- All regressions include additional controls for: Absolute difference in longitudes to Paris, absolute difference in latitudes to Paris, dummy =1 if region is barred from France by a mountain range, dummy for contiguity to France, dummy if region shares at least one sea or ocean with France, dummy for landlocked region, dummy for region being on an island.
- Country fixed-effects are period-specific due to changing borders.
- Ig was multiplied by 1,000 for readability of the estimates.
- In terms of their 1946 borders, countries to which regions in the sample belong are as follows:
    - Column (1): Denmark, England and Wales, France, Netherlands, Switzerland.
    - Column (2): as in column (1) plus: Austria, Belgium, Finland, Germany, Ireland, Italy, Norway, Poland, Russia, Scotland, Sweden, Czechoslovakia, Hungary, Romania, Yugoslavia.
    - Column (3): as in column (2) plus Greece, Luxemburg, Portugal, Spain.
    - Columns (4) and (5): as in columns (3) plus Bulgaria.
    - Column (6): as in columns (4) and (5) minus Czechoslovakia.
- (*): Common sample of 630 regions from the following 23 countries: Austria, Luxemburg, Belgium, Denmark, England and Wales, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Russia, Scotland, Spain, Sweden, Switzerland, Hungary, Romania, Yugoslavia.

Table 6 - Ig Regressions with Country Fixed-Effects and Additional Controls, Period 5 (1871-1900)
(Dependent variable: Index of Marital Fertility, Ig)

	(1)	(2)	(3)	(4)	(5)	(6)
	Infant Mortality	**Population Density**	**Urbanization Rate**	**Literacy**	**All but IMR**	**All additional controls**
# of different nodes with Français	25.223 (8.78)***	15.741 (6.31)***	14.580 (5.55)***	27.289 (12.36)***	19.883 (6.16)***	26.135 (4.58)***
Geodesic distance to Paris, Km	0.113 (0.72)	-0.037 (0.58)	-0.003 (0.03)	-0.110 (1.42)	-0.072 (0.79)	-0.080 (0.42)
Infant Mortality Rate	355.760 (2.16)**					473.437 (2.10)**
Population density, mid-19th century		-0.015 (3.60)***			-0.009 (1.86)*	-0.006 (0.89)
Urbanization rate 1850 (Bairoch)			-101.998 (4.60)***		-64.724 (2.04)**	-130.911 (2.28)**
Literacy rate in 1880				-0.728 (2.31)**	-0.526 (1.32)	-1.020 (1.40)
Constant	357.240 (4.17)***	546.746 (10.58)***	550.971 (8.88)***	378.741 (3.98)***	520.362 (7.85)***	475.055 (5.28)***
R^2	0.61	0.64	0.66	0.67	0.66	0.66
Number of regions (Number of countries, 1946 borders)	285 (6)	519 (18)	403 (18)	408 (8)	297 (7)	178 (3)
Standardized Beta on linguistic distance from Français (%)	57.520	35.601	33.024	60.697	44.842	59.574

Notes:
- t-statistics in parentheses: * *p*<0.1; ** *p*<0.05; *** *p*<0.01
- All regressions include additional controls for: Absolute difference in longitudes to Paris, absolute difference in latitudes to Paris, dummy=1 if region is barred by a mountain range from France, dummy for contiguity to France, dummy=1 if area shares at least one sea or ocean with France, dummy=1 if region is landlocked, dummy=1 if region is on an island.
- Country fixed effects are defined as per 1886 political borders.
- In terms of their 1946 borders, countries to which regions in the sample belong are as follows:
  - Column (1): Belgium, Denmark, England and Wales, France, Germany, Switzerland.
  - Columns (2) and (3): Austria, England and Wales, Finland, France, Germany, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Portugal, Romania, Scotland, Spain, Sweden, Switzerland.
  - Column (4): Austria, Belgium, England and Wales, France, Germany, Hungary, Italy, Spain.
  - Column (5): Austria, England and Wales, France, Germany, Hungary, Italy, Spain
  - Column (6): England and Wales, France, Germany.

Table 7 - Regressions for the Economic Determinants of Fertility, with Country Fixed-Effects (Dependent variables: As displayed in the second row)

	(1)	(2)	(3)	(4)
	Infant Mortality Rate Period 5 (1871-1900)	**Population Density (mid 19th century)**	**Urbanization 1850**	**Literacy 1880**
# of different nodes with Français	0.003 (2.82)***	-14.447 (0.54)	-0.005 (0.87)	-0.260 (0.72)
Geodesic distance to Paris, km	0.0003 (4.71)***	-0.872 (1.28)	0.0001 (0.01)	-0.041 (3.28)***
Constant	0.144 (6.87)***	386.154 (0.70)	0.082 (0.57)	99.229 (6.83)***
R^2	0.45	0.02	0.24	0.74
Number of regions (Number of countries)	285 (6)	520 (19)	404 (19)	410 (8)
Standardized Beta on linguistic distance from Français (%)	20.662	-4.663	-9.815	-3.669

Notes:

- t-statistics in parentheses: * *p*<0.1; ** *p*<0.05; *** *p*<0.01
- All regressions include additional controls for: Absolute difference in longitudes to Paris, absolute difference in latitudes to Paris, dummy=1 if region is barred by a mountain range from France, dummy for contiguity to France, dummy=1 if area shares at least one sea or ocean with France, dummy=1 if region is landlocked, dummy=1 if region is on an island. Country fixed effects are defined as per 1886 political borders.
- In terms of their 1886 borders, countries to which regions in the sample belong are as follows:
  - Column (1): Belgium, Denmark, England and Wales, France, Germany, Switzerland.
  - Columns (2) and (3): Austria, England and Wales, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Norway, Poland, Portugal, Romania, Scotland, Spain, Sweden, Switzerland.
  - Column (4): Austria, Belgium, England and Wales, France, Germany, Hungary, Italy, Spain.

Table 8 - Regional Regressions for Ig, Horserace with England, with Country Fixed-Effects (Dependent variable: Index of Marital Fertility, Ig)

	(1)	(2)	(3)	(4)	(5)	(6)
	Period 1 (1831-1860)	**Period 3 (1851-1880)**	**Period 5 (1871-1900)**	**Period 7 (1891-1920)**	**Period 9 (1911-1940)**	**Period 11 (1931-1960)**
# of different nodes with Français	18.015 (4.21)***	24.092 (11.78)***	22.816 (11.24)***	21.718 (9.89)***	14.114 (6.86)***	9.423 (5.50)***
# of different nodes with English	7.313 (0.60)	4.432 (0.82)	6.689 (1.21)	15.703 (2.64)***	9.368 (1.63)	14.040 (2.86)***
Geodesic distance to Paris, km	0.378 (1.39)	0.329 (2.97)***	0.383 (3.72)***	0.420 (3.75)***	0.132 (1.48)	0.052 (0.70)
Geodesic distance to London, km	-0.827 (3.58)***	-0.401 (3.85)***	-0.450 (4.66)***	-0.439 (4.18)***	-0.162 (2.02)**	-0.089 (1.34)
Constant	595.511 (5.53)***	470.479 (10.64)***	490.791 (10.96)***	381.398 (7.96)***	35.103 (0.62)	157.904 (3.55)***
R^2	0.72	0.71	0.63	0.61	0.66	0.66
Number of regions	184	531	659	675	766	748
Standardized Beta, linguistic distance to France (%)	45.398	56.619	51.325	46.601	29.015	22.755
Standardized Beta, linguistic distance to England (%)	5.078	3.608	5.692	13.398	7.982	13.360

Notes:
- t-statistics in parentheses: * $p<0.1$; ** $p<0.05$; *** $p<0.01$
- All regressions include additional controls for: Absolute difference in longitudes to Paris, absolute difference in longitudes to London, absolute difference in latitudes to Paris, absolute difference in latitudes to London, dummy for contiguity to France, dummy for contiguity to England, dummy=1 if area shares at least one sea or ocean with France, dummy=1 if area shares at least one sea or ocean with England, dummy=1 if region is landlocked, dummy=1 if region is on an island, dummy=1 if region is barred by a mountain range from France.
- Country fixed-effects are period-specific due to changing borders.
- Ig was multiplied by 1000 for readability of the estimates.
- In terms of their 1946 borders, countries to which regions belong are as follows:
  - Column (1): 5 countries as follows: Denmark, England and Wales, France, Netherlands, Switzerland.
  - Column (2): 20 countries as follows: as in column (1) plus: Austria, Belgium, Finland, Germany, Ireland, Italy, Norway, Poland, Russia, Scotland, Sweden, Czechoslovakia, Hungary, Romania, Yugoslavia.
  - Column (3): 24 countries as follows: as in column (2) plus Greece, Luxemburg, Portugal and Spain.
  - Columns (4) and (5): 25 countries as follows: as in column (3) plus Bulgaria.
  - Column (6): 24 countries as follows: as in columns (4) and (5) minus Czechoslovakia.

Figure 1 – Map of the Fertility Transition Dates
(Source: Coale and Watkins, 1986)

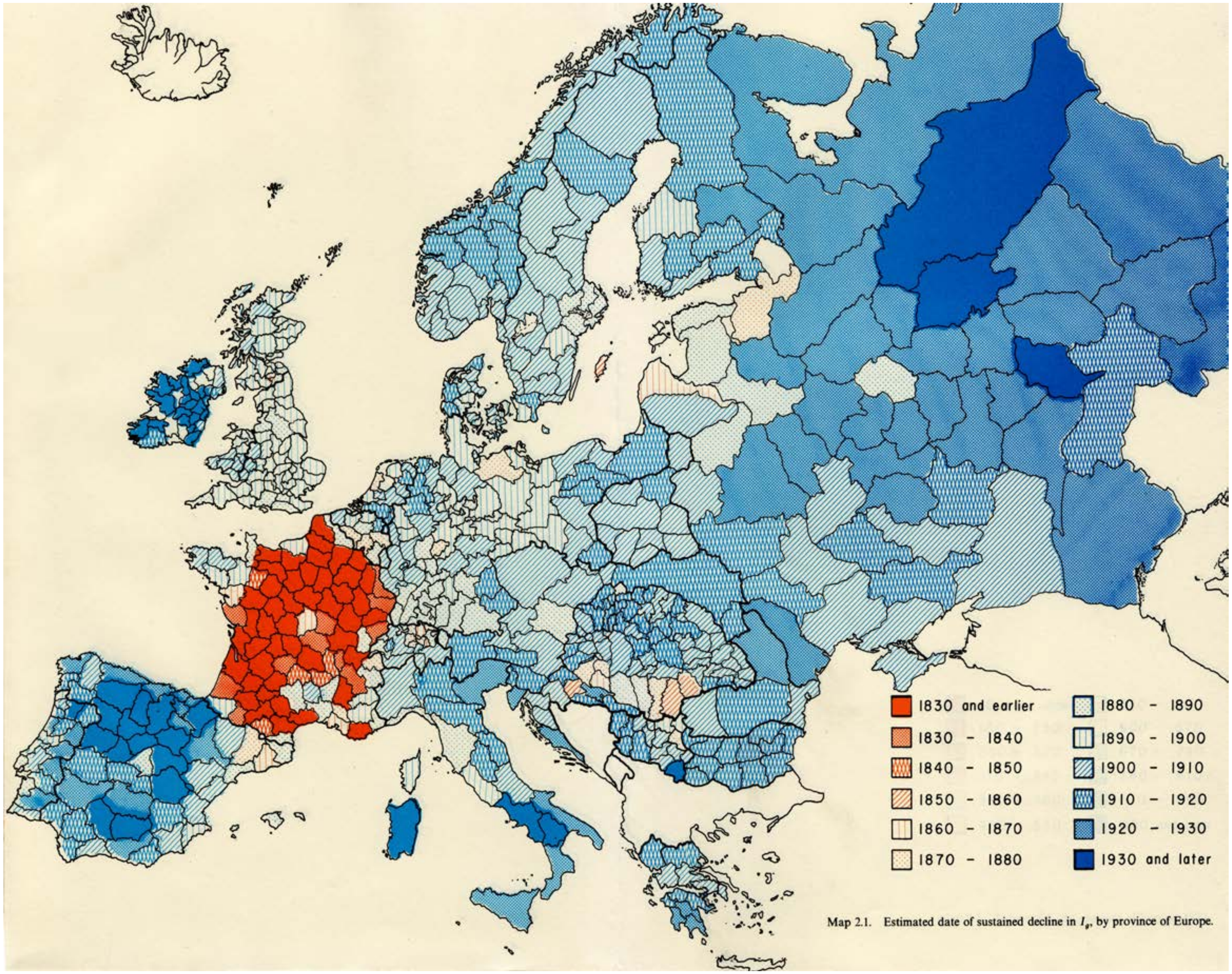


Figure 2 - Cumulative Distribution of Fertility Transition Dates

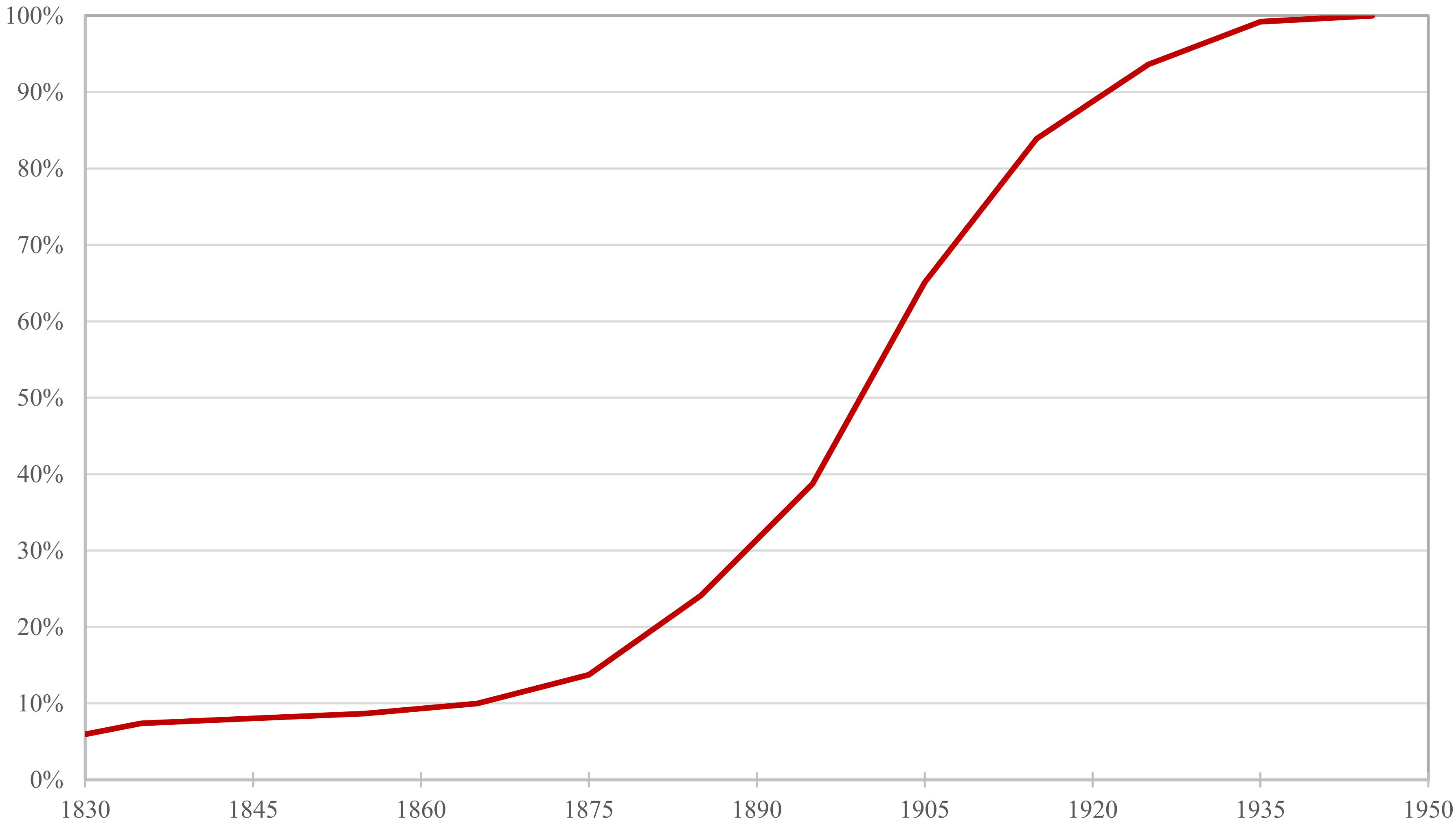
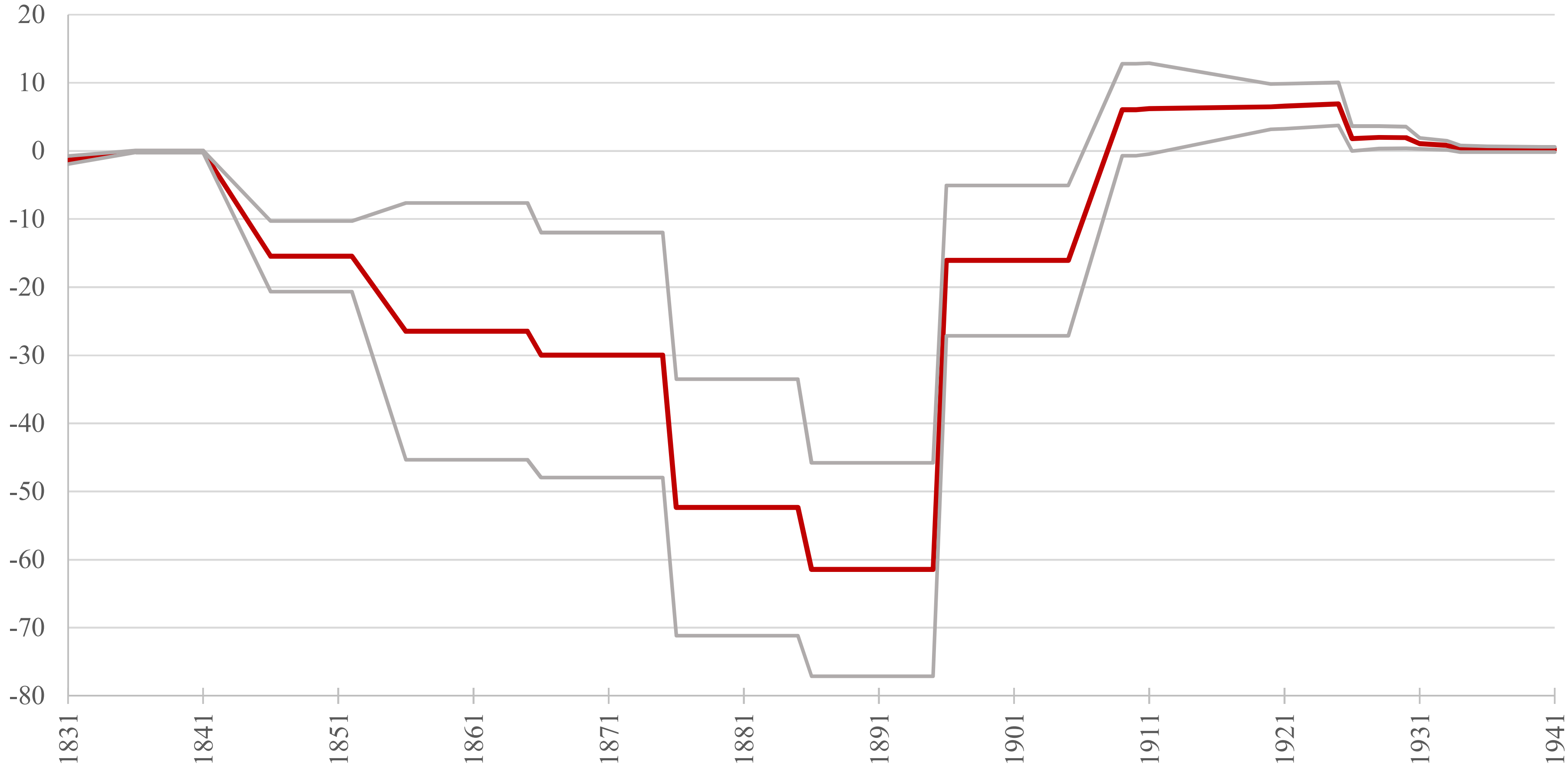
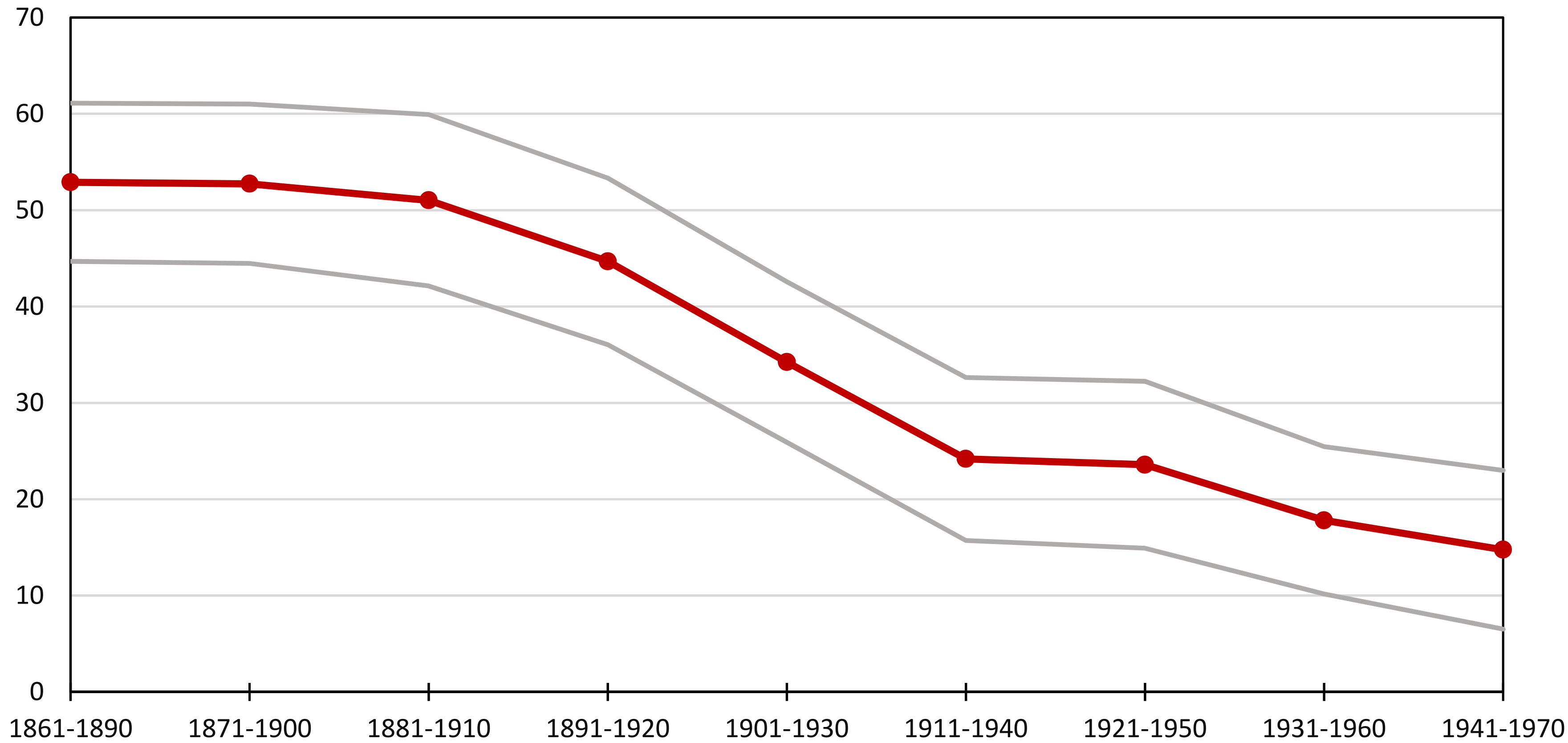


Figure 3 - Standardized Effect of Linguistic Distance to Français on the Probability of Having Experienced the Fertility Transition (95% CI in grey)



This chart depicts the standardized effect of linguistic distance to Français on the probability of having experienced the fertility transition, defined by a 10% decline in Ig, prior to the date on the x-axis. Estimates are obtained from cross-sectional probit specifications run at periodic dates between 1831 and 1941 in a balanced sample of 771 European regions.

Figure 4: Standardized Effect of Linguistic Distance to Français on Ig, common sample (95% CI in grey; 30 year bandwidth)



This chart depicts the standardized effect of linguistic distance to Français on marital fertility (I_g) through time, in overlapping samples of 30 years depicted on the x-axis. The sample is a balanced sample of 519 European regions.