THE
ECONOMIC
JOURNAL

The Economic Journal, 1–38 https://doi.org/10.1093/ej/ueab066

FERTILITY AND MODERNITY*

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We investigate the determinants of the fertility decline in Europe from 1830 to 1970 using a newly constructed data set of linguistic distances between European regions. The decline resulted from the gradual diffusion of new fertility behaviour from French-speaking regions to the rest of Europe. Societies with higher education, lower infant mortality, higher urbanisation and higher population density had lower levels of fertility during the nineteenth and early twentieth centuries. However, the fertility decline took place earlier in communities that were culturally closer to the French, while the fertility transition spread only later to societies that were more distant from the frontier. This is consistent with a process of social influence, whereby societies that were culturally closer to the French faced lower barriers to learning new information and adopting novel attitudes regarding fertility control.

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 data set of linguistic distances between European regions. We find that the modern decline resulted from the gradual diffusion of new fertility behaviour 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 industrialisation followed different patterns because societies at different 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, emphasises changes to the incentives for having children, stemming, for instance, from urbanisation or improved health and human capital (Becker, 1960; Galor, 2011). The other approach, more popular among demographers, sociologists, and anthropologists, interprets the fertility change in terms of cultural transmission of new attitudes and norms (Knodel and Van de Walle, 1979; Coale and Watkins, 1986; Newson *et al.*, 2005; Richerson and Boyd, 2005, pp. 169–73; Newson and Richerson, 2009). We view the two approaches as complements rather than substitutes. In our theoretical and empirical analysis, fertility choices are impacted by the intrinsic costs and benefits from having children, but also by new information and social norms that diffuse first across culturally related groups.

Our starting point is the Princeton project on the decline of fertility in Europe (Princeton European Fertility Project, henceforth PEFP) (Coale and Watkins, 1986), which was the

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This paper was received on 8 June 2020 and accepted on 10 August 2021. The Editor was Hans-Joachim Voth.

The data and codes for this paper were checked for their ability to reproduce the results presented in the paper. The replication package for this paper is available at https://doi.org/10.5281/zenodo.5123362.

We thank Quamrul Ashraf, Guillaume Blanc, John Brown, Matteo Cervellati, David De La Croix, Gilles Duranton, Alan Fernihough, Raphael Franck, Oded Galor, Raphael Godefroy, Michael Huberman, Yannis Ioannides, Noel Johnson, David Le Bris, Monica Martinez-Bravo, Jacques Melitz, Deborah Menegotto, Omer Moav, Luigi Pascali, Andrés Rodríguez-Pose, Nico Voigtländer, Joachim Voth, Susan Watkins, David Yanagizawa-Drott as well as participants at numerous seminars and conferences for useful comments. Shriya Didwania, Jack Ma, Andrea Di Miceli and Youngjin Song provided excellent research assistance. Any remaining errors are ours.

outcome of a massive interdisciplinary research effort carried out at Princeton University's Office of Population Research in the 1960s and 1970s. This study remains the most comprehensive source of historical data on fertility across European regions in the nineteenth and early twentieth centuries, documenting a dramatic decline of fertility in society after society over the past two centuries. Europe had experienced fluctuations in overall fertility before (Livi-Bacci, 2001). However, in pre-modern times, fertility control took place mostly through marriage postponement, celibacy and other forms of control that affect the probability of conception irrespective of the number of children already produced.[1] In contrast, PEFP authors attributed the modern fall in fertility to parity-specific limitations (Coale, 1986, pp. 9–10), defined as behavioural changes adopted to avoid additional births after the desired number of children has been born. The 'ideal' that couples should 'marry, have a small number of kids, and stop' is a modern innovation, which became widespread among European populations only during the past two centuries.[2] Most importantly from our perspective, PEFP scholars prominently argued that the change in fertility behaviour spread from France, mostly along cultural and linguistic lines.

The Princeton project spurred a vigorous debate on the role of economic channels in the demographic transition (Friedlander *et al.*, 1991; Guinnane *et al.*, 1994; Brown and Guinnane, 2007). 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 industrialisation.[3] 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 living standards to lower fertility was at the centre of Becker's (1960) classic argument that industrialisation would lead to lower fertility by increasing the opportunity cost of raising children. However, the pattern of fertility transition in Europe during the nineteenth and twentieth centuries was not consistent with a simple story linking industrialisation and lower fertility, because societies at relatively low levels of development experienced a decline in fertility at the same time, or even before, economically more advanced societies such as England (Coale and Watkins, 1986).[4]

While the decline of fertility in Europe was not a direct result of industrialisation, economic incentives may still have played a role in fertility decisions. Substantial empirical support exists for economic theories that connect advancements in health and human capital to lower incentives to have children. A decline in child mortality enabled families to attain the same number of surviving children with lower fertility rates (Preston, 1978; Doepke, 2005). Human capital formation and improved health also reduced fertility by leading to a substitution of child quality

[1] Demographers call such forms of control 'non-parity specific'. See Voigtländer and Voth (2013) for a discussion of marriage postponement in Europe starting in medieval times as a means to reduce total fertility.

[2] PEFP's critics questioned this parity-specific interpretation, arguing that marital fertility might also have been reduced through changes in behaviour typically considered as non-parity specific, such as changes in breastfeeding (Guinnane *et al.*, 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. What matters, for us, is the emergence of a major change in attitudes towards fertility control within marriage, leading to much lower observed fertility.

[3] In Coale and Watkins (1986)—see for example Chapter 1 by Coale and Watkins, Chapter 7 by Anderson (1986), and Chapter 10 by Knodel and Van de Walle.

[4] Becker's mechanism may not hold empirically because the substitution effect, reducing the desired number of children, could be offset by the income effect, which raises desired fertility (see Galor, 2011, p. 118). In the Online Appendix, we find that per capita income is not a significant determinant of fertility levels in the late nineteenth century, nor of the timing of the fertility transition, using a sample of 37 European populations.

for quantity (Galor and Weil, 2000; Bleakley and Lange, 2009; Becker *et al.*, 2010). Franck and Galor (2015) stress the role of human capital accumulation when studying the effects of industrialisation on the fertility decline in France itself.[5] Yet, as emphasised by PEFP authors, during the nineteenth century in Europe, regions with similar levels of human capital transitioned to lower fertility at different times, and earlier transitions tended to be associated with linguistic proximity to France. For example, French-speaking households in Belgium reduced their fertility to modern levels decades before Dutch-speaking households with similar levels of income and education (Lesthaeghe, 1977).

In this paper, we provide a theoretical and empirical analysis of fertility decline that reconciles an emphasis on cultural channels with a role for economic forces and incentives. We present a model where the transition from higher to lower fertility is the outcome of innovation and social influence. In our framework, higher 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 beliefs and norms that regulate marital fertility. It is only when traditional attitudes are abandoned that people change their behaviour. At the beginning, only societies close to the cultural innovators experience reduced fertility. Over time, the 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 urbanisation and higher population density had lower levels of fertility during the nineteenth and twentieth centuries. However, the fertility decline took place much earlier and was initially larger in communities that were culturally closer to the French. We also find that the effect of linguistic distance from the French remains large and significant when controlling for regional differences in traditional family types, as defined by Emmanuel Todd (Todd, 1985; 1990; Duranton *et al.*, 2009).[6] Finally, we find that the effect of linguistic distance from French is robust to controlling for exogenous predictors of industrialisation (distance to coal deposits) as well as for linguistic distances to English and other languages spoken in Europe.

Our interpretation of these results is that linguistic distance mattered in the transmission of the fertility decline because individuals in societies that were linguistically closer to the innovator faced lower barriers to learn about new information, behaviours and attitudes. 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 and to learn from each other. This does not mean that these traits themselves have a direct effect on the probability of adopting the new behaviour. Indeed, the new fertility behaviour 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 temporary barriers to the diffusion of

[5] Diebolt *et al.* (2017) also discuss the education–fertility connection during France's demographic transition. Murtin (2013) highlights the role of human capital in the demographic transition for a worldwide sample of countries. Galor and Moav (2002) propose an evolutionary theory of the trade-off between the quality and quantity of children. Moav (2005) provides a theory of the persistence of poverty, linking high fertility and low investment in child quality. For a review of the literature on investment in human capital and fertility, see Cinnirella (2019).

[6] Interestingly, these ancestral family types also continued to have an impact on fertility behaviour during the nineteenth and twentieth centuries when major changes in fertility behaviour across Europe were diffusing from France.

innovations, rather than the direct effects of culturally transmitted traits on behaviour.[7] Overall, our findings support the view that economic forces are important, but not sufficient to explain the dynamics of the fertility transition; and that cultural and linguistic variables played a key role in the transmission of the new fertility behaviour, as emphasised by the Princeton project scholars (see also Richerson and Boyd, 2005, pp. 172–3). The emergence and diffusion of new information and norms about fertility behaviour and family planning—more broadly related to the spread of secular beliefs and attitudes—were key features of modernisation. However, they did not necessarily go hand in hand with other aspects of modernisation more closely associated with economic development and industrialisation, which had different cultural and geographical origins, even though, eventually, most regions of Europe were transformed along all dimensions of modernity during the nineteenth and twentieth centuries. In a nutshell, our results suggest that the spread of modernity was a multi-faceted phenomenon, which is best understood only by considering both culture *and* economics.

Our analysis is related to empirical studies of changes in fertility that emphasise cultural and social effects. The impact of social networks on fertility in African countries has been studied by Montgomery *et al.* (1998) and Behrman *et al.* (2002; 2009). Munshi and Myaux (2006) find that social norms explain why the same fertility interventions had different effects along ethnic and religious lines in India. La Ferrara *et al.* (2012) estimate the effect of new television-transmitted norms on the fertility behaviour of Brazilian women. Manski and Mayshar (2003) explain fertility differences across ethnic-religious groups in Israel through the interplay of private and social incentives, including conformity to group fertility norms. Daudin *et al.* (2019) analyse the role of internal migration and social interactions in the diffusion of fertility decline within nineteenth-century France. De La Croix and Perrin (2018) discuss possible complementarities of economic incentives and cultural factors in fertility behaviour, and find that a 'parsimonious rational-choice model' can explain 38% of variation in fertility over time and across French regions during the nineteenth century. They also analyse the residuals (unexplained by their economic model) and conclude that 'additional insights might be gained by interacting incentives with cross-county differences in family structures and cultural barriers'. Our study differs from their approach as we provide explicit measures of cultural barriers and focus not only on France, but on the diffusion of the fertility decline across all regions of Europe.

Our contribution is also connected to the broader literature on social interactions. Our theoretical framework builds on Akerlof (1997). It is also linked to Young's (2009) analysis on the diffusion of innovations in models of social influence and social learning, and to Fogli and Veldkamp's (2011) study on the diffusion of female labour force participation in the United States.[8] Finally, our paper is related to research studying the spread of productivity-enhancing innovations associated with the diffusion of the Industrial Revolution from England to other societies. This was the topic of some of our previous work (Spolaore and Wacziarg, 2009; 2012;

[7] An interesting question is whether linguistic features, such as grammatical structures, might be correlated to, or even affect, fertility-relevant beliefs and norms, for instance, about gender (Gay *et al.*, 2018; Jakiela and Ozier, 2018). Galor *et al.* (2018) argue that such linguistic traits co-evolved with other cultural traits and stemmed from deep geographical roots, going back to earlier specialisation in different forms of agriculture. Thus, such features should have persistent effects on fertility, rather than affecting the dynamics of the modern transition. In contrast, our analysis points to an indirect effect of linguistic distance on fertility behaviour, operating as a temporary barrier to the spread of new information and norms, and only affecting the speed of adoption. Indeed, all the societies in our data set eventually adopted the novel behaviour, independent of their deeper linguistic and cultural traits.

[8] Discussions of the economic literature on social interactions are provided by Durlauf and Ioannides (2010) and Ioannides (2013). Contributions that link culture and economics are surveyed in Bisin and Verdier (2010), Spolaore and Wacziarg (2013), Spolaore (2014) and Alesina and Giuliano (2015).

2013; 2018). However, as we document here, the diffusion of the fertility decline and the spread of industrialisation started at different frontiers and followed different patterns, because societies at different cultural distances from the respective innovators (the French and the English) faced different barriers to learning and adoption.

1. Background and Data

1.1. *Historical Background*

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. The role of France was emphasised by the authors of the Princeton Project (Coale and Watkins, 1986), and was central to their interpretation of the demographic transition as a cultural phenomenon. Remarkably, there was significant variation across French *départements* (administrative divisions or counties), 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 was far from standard French, the first 10% decline in marital fertility only happened in 1905.[9] Similarly, in Belgium during the nineteenth century, French-speaking households in Wallonia reduced their fertility to modern levels long 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 neighbours 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'. Specifically, Lesthaeghe studied 70 Walloon villages matched to neighbouring Flemish villages with similar economic conditions, and found that fertility fell first in the Walloon village in 62 of the pairs. On average, fertility started to decline 20 years earlier in the Walloon communities. 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 began its transition to modern fertility in 1865, while Bilbao did so only in 1925.[10] 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.[11]

An open question, widely debated by historians and demographers, is why the transition to lower marital fertility started in France. Several factors likely contributed to the onset of the fertility transition within French society. One is the cultural development towards secular modern

[9] 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 example, see Blanc and Wacziarg (2020) and the references therein.

[10] Correspondingly, the levels of marital fertility (I_g, as defined in Subsection 1.2), averaged over the 1881–1910 period were 0.499 in Liège and 0.796 in Bruges, 0.460 in Barcelona and 0.710 in Bilbao.

[11] In his investigation of the decline of fertility in Spain between 1900 and 1950, Leasure (1963) found sharp regional differences in marital fertility across different 'historical and linguistic regions in Spain'. In contrast, within each region, provincial fertility rates were 'fairly constant regardless of whether the province is rural or urban, agricultural or industrial'. He concluded that 'cultural factors, which may arise from a common historical and linguistic heritage within a region, are closely associated with fertility in some complex relationship'.

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 centres of political and cultural influence—therefore determining or facilitating changes in norms and behaviour. As France started to experience a decline in fertility in the second half of the eighteenth century, a few contemporary observers attributed the new phenomenon to a change in moral standards. For example, Jean-Baptiste Moheau (1778) noticed that the French were having fewer 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 an 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. Blanc finds that this religiosity measure has a large and significant impact on fertility a generation later (in 1831).[12] 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, urbanisation, 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 reforms outside France have been studied by Acemoglu *et al.* (2011). Relatedly, Lecce and Ogliari (2019) find that the effect of the adoption of formal Napoleonic institutions on economic performance in German regions depended on cultural (religious and linguistic) proximity to France. Cultural proximity to France may also have impacted the effects of secular Napoleonic institutions on fertility, because societies that were culturally close to the French tended to embrace 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 is broadly consistent with an interpretation in terms of cultural diffusion of novel norms and behaviour from France.[13]

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 nineteenth century took place well before modern methods of contraception had become widely available, so that French fertility was reduced using rudimentary natural methods, such as withdrawal, which had been known since biblical times (Van de Walle, 2005, p. 4). More generally, as pointed out by Knodel and Van de Walle (1979, p. 217): 'Much of the fertility decline in Europe took place before modern contraception or safe medical abortion were readily available, and thus couples who limited their family size must have done so through withdrawal or abstinence, that is, through

[12] Murphy (2015), using French department-level data, also finds evidence for an effect of secularisation on the fertility decline during the demographic transition.

[13] In the empirical analysis, we control for region-level measures of economic development and for country fixed effects. Thus, we account 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 and depend on cultural distance from France.

methods theoretically available to everyone'. 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). In general, it is conceptually and empirically difficult to disentangle whether the main mechanism behind the onset and spread of the fertility transition, first within France and then from French society to neighbouring communities, was new information about contraception and family planning or new social norms that reduced the stigma attached to already well-known natural methods of fertility control. In either case, the key empirical feature that we investigate here is that the novel fertility behaviour originally emerged in France and then spread along cultural lines, with populations closer to the French being more likely to learn about the new behaviour 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, and abstract from whether the transition occurred mainly through the spread of new information, new social norms and attitudes, or a combination of the two.[14]

The interplay of the diffusion of new information and changing societal and moral attitudes is at the centre of the Bradlaugh-Besant trial, an important historical event related to the demographic transition. 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. Their arrest, trial, conviction and eventual acquittal brought issues of family planning to the forefront of discussion among the general public (Field, 1931; Chandrasekhar, 1981). 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.[15] Consistent with our diffusion hypothesis, Besant and Bradlaugh defended themselves by citing French teachings and practices stemming from the weakening of traditional religious beliefs and the emergence of secular attitudes.[16]

1.2. *Data and Measurement*

1.2.1. *Marital fertility*

Our empirical analysis is based on the Princeton project on the decline of fertility in Europe, PEFP (Coale and Watkins, 1986). This remains the main source for data on fertility in Europe during the nineteenth and twentieth centuries, notwithstanding subsequent conceptual and methodological

[14] As noted for instance by Greif (2006), it is in general challenging to model and study both the emergence and the diffusion of a behavioural or institutional innovation within the same framework.

[15] According to Beach and Hanlon (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'.

[16] As reported 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 . . . while 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'.

criticisms (Guinnane *et al.*, 1994; Brown and Guinnane, 2007).[17] The database of fertility rates in PEFP includes detailed information on various measures of fertility across 775 regions of 25 European countries from 1831 to 1970. In our empirical analysis, we focus on I_g, the index of marital fertility.[18] 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.[19] For any society i:

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

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 fertility schedule of the Hutterites, while the numerator is the actual number of children born to married women.

1.2.2. *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 represent 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.[20] At any date t the fertility transition status T_t is then defined as 1 if $t \geq FTD$ and 0 otherwise.

[17] For instance, some interpretations in the original studies were based on the presumption of a simultaneous adoption of the new fertility behaviour by all households across heterogeneous societies. Instead, critics noted that 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 behaviour spread to most other households in their society (Guinnane *et al.*, 1994, p. 3). In our theoretical framework in Section 2, we explicitly allow for a gradual diffusion across heterogeneous households within each society.

[18] Overall fertility did not differ much from marital fertility in European societies during the nineteenth and early twentieth century, because relatively few births occurred outside marriage. A benefit of focusing on marital fertility is that, by definition, it is the variable most directly affected by changes in attitudes towards *fertility control within marriage*, which played a paramount role during the fertility transition. An interesting question is to what extent the dynamics of fertility (overall and within marriage) might also have been affected by changes in attitudes towards marriage itself (whether and when to marry). Our data set does not contain information on age at marriage or birth spacing, so we leave this issue for future research.

[19] See Coale and Treadway (1986, p. 153).

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

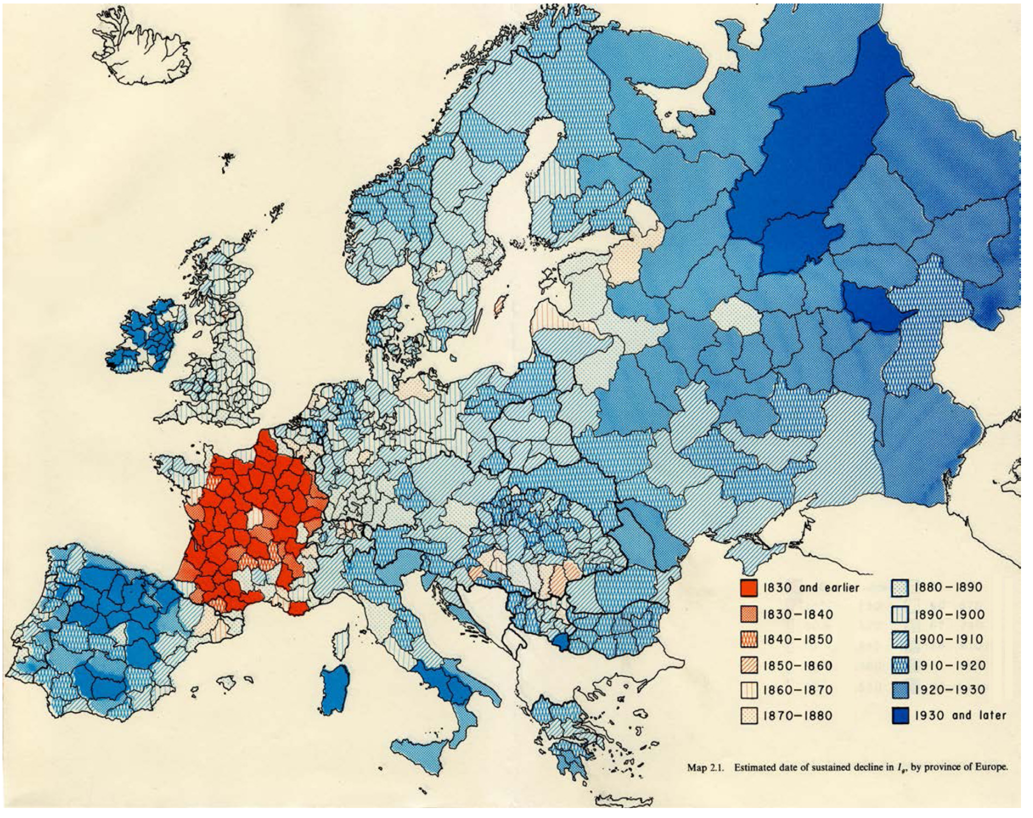

Fig. 1. *Map of the Fertility Transition Dates.*
Source: Coale and Watkins (1986).

1.2.3. *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. Typically, 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.[21]

To construct a measure of linguistic distance across the regions of Europe, we 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 eighteenth and nineteenth centuries, we matched every language in the source map to a sub-national region in the fertility data set from Coale and Watkins

[21] 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 more broadly as an indicator of cultural distance: the barriers captured by linguistic distance include communication, trust, differences in norms, values and attitudes.

(1986).[22] We ended up with 275 languages and dialects matched as primary languages of each of the 775 regions.[23] It is important to note that these languages are no longer necessarily spoken in the corresponding regions, as the nineteenth and twentieth centuries saw the virtual elimination of many sub-national dialects in several European countries through nation building (Weber, 1976). For instance, regions of southern France are variously matched to Langue d'Oc, Provençal, or Savoyard, spoken nowadays by very few people. Linguistic distance based on eighteenth- and nineteenth-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 the Ethnologue website (ethnologue.com).[24] 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). We did so by counting the number of different linguistic nodes separating any pair of languages.[25] Then, using the primary languages of each region, we obtained a series describing the linguistic distance of each region in our regional data set to every other. The series on the number of different linguistic nodes to French ('Français') ranges from 1 to 10, with a mean of 7.4 and a standard deviation of 3. 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.

1.2.4. *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 all other regions. 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.

1.2.5. *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

[22] 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, the language headings used in this map closely track those in the Ethnologue website, on which we rely to derive linguistic distance.

[23] 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. Some 108 of the 775 regions are matched to a secondary language. In most cases, 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 three sub-divisions of Brittany (each of which is matched to a different 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.

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

[25] For instance, the linguistic classification of Italian is Indo-European—Italic—Romance—Italo-Western—Italo-Dalmatian. Thus, Italian shares four nodes in common with French out of a possible ten nodes, and its 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 linguistic distance.

data at the regional level on urbanisation rates in 1800 and 1850, population density in the mid-nineteenth century and literacy rates in 1880. Finally, we gathered data on each region's distance to coalfields and carboniferous rock strata to capture the proximity of industrialisation. Indeed, early industrialisation required proximity to coal in order to power steam engines (Fernihough and O'Rourke, 2021). Due to availability constraints, the data on intrinsic determinants cover many, but not all 775 regions for which marital fertility data is available. The Online Appendix describes the sources and coverage of these data in greater detail.

1.2.6. *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 regional 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 (for example, Alsace and the Moselle department of Lorraine were part of France until the Franco-Prussian War of 1870–1871, part of Germany from 1871 to 1918, and part of France again after World War I). Country fixed effects can then be defined using country borders at different points in time.

1.2.7. *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 centred at 10-year intervals, so that period 1 is 1831 to 1860, period 2 is 1841 to 1870, etc.[26] 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 the fertility transition status at each point in time, both of which are available for 771 regions.

2. 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, knowledge and social norms about fertility control, and the process of social influence through which norms change

[26] For the first period data was available only for 184 regions from five 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 twentieth century.

and diffuse across different societies. This model generates testable implications regarding the pattern of diffusion of new fertility behaviour.

2.1. *The Framework*

Consider a household i that chooses marital fertility f_i to maximise 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.[27] 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 have when no fertility control is adopted. The assumption that all traditional societies are at the natural level of fertility is made for analytical simplicity and should not be taken too literally.[28] 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 in terms of technological knowledge—that is, σ is decreasing in the costs of fertility-control techniques (information about fertility control, availability of 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 second interpretation of the parameter σ is in terms of social norms; agents pay a marginal cost σ when they reduce fertility below f_n because of a social or moral stigma associated with using fertility control and achieving fertility below the maximum. Empirically, we will not distinguish between the two interpretations. However, as mentioned in the previous section, indirect evidence suggests that it was not only information about contraception that diffused across societies, but also new attitudes about fertility control within marriage. Thus, in the rest of this section, to fix ideas, we focus on the interpretation of σ as social norms.

The equilibrium choice of fertility is

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

We can distinguish between traditional societies, where households choose $f^* = f_n \leq (b + \sigma)/c$, and modern societies, where households choose $f^* = (b + \sigma)/c < f_n$. Then, fertility choice can be in one of three possible equilibria:

1. *Intrinsically optimal traditional equilibrium*: $f^* = f_n \leq b/c$ for all $\sigma \geq 0$. 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 high relative to intrinsic costs, social norms that impose additional 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.

[27] The expression *intrinsic utility* is borrowed from Akerlof (1997). Following our approach, the same utility specification has been used by Chabé-Ferret (2019) to study fertility decisions.

[28] Even in pre-modern societies there existed some measures to reduce fertility below its maximum natural rate. However, fertility remained high in traditional societies and was not reduced through modern forms of fertility control within marriage.

2. *Intrinsically sub-optimal traditional equilibrium:* $b/c < f^* = f_n \leq (b+\sigma)/c$. Fertility is above the intrinsic optimum and social norms against fertility control are binding. This equilibrium can hold only if σ is sufficiently large ($\sigma \geq cf_n - b > 0$). Now, a reduction in σ matters for fertility choices and positively affects indirect utility.
3. *Modern equilibrium:* $f^* = (b+\sigma)/c < f_n$. 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 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 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.

2.2. *The Diffusion of the Fertility Decline*

We now introduce social change from traditional equilibria where $f^* = f_n$ to modern equilibria where $f^* < f_n$. 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 pre-condition 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.

Consider three societies: X, Y and Z, each inhabited by a continuum of households with mass normalised to 1. At time $t < 0$, all households in the three societies are at an intrinsically sub-optimal 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 becomes $\sigma_1 < cf_n - b < \sigma_0$, and society X goes to the new modern equilibrium $f^* = f_m \equiv (b+\sigma_1)/c < f_n$.[29]

The change in social norms in society X affects decisions in societies Y and Z through a mechanism of social influence. At each time $t > 0$, each household in Y and Z considers whether to adopt the new social norm parameter σ_1 or to stick to the old value σ_0. While all households would gain from the switch in terms of intrinsic utility, 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.[30] When deciding whether to conform to the new or to the old

[29] We assume that all households in society X experience the shift to the new modern equilibrium simultaneously. The model can be generalised to allow for a gradual diffusion of the new norms within society X, starting from a sub-set of innovators.

[30] We abstract from factors that may differentially affect fertility across individuals *within* traditional societies and *within* modern societies. As societies transition from traditional to modern fertility, the variance of fertility behaviour within each society will first increase and then decrease over time. Our data set only allows us to study average fertility within each region. Thus, we do not focus on changes in the variance of fertility across individuals within each region. The model could be extended to include heterogeneity in intrinsic incentives across individuals, as well as shocks creating a wedge between desired and actual fertility. During the fertility transition, households could become more effective at reducing this wedge, therefore lowering the overall variance of fertility across individuals over time, as in the recent empirical work by Hruschka and Burger (2016).

social norms, each household in societies Y and Z weighs the influence of other households based on their respective social distance. Social distance between two agents captures the extent to which they are likely to have socially valuable interactions and, therefore, to care about each other's preferences and behaviour 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*.[31] Let $d(i, j) = d(j, i)$ denote the social distance between agent i and agent j. All households within Y are at $d(Y, Y) = 0$ from each other and all households within Z are at $d(Z, Z) = 0$ from each other. Each household in Y is at $d(X, Y) = d(Y, X) > 0$ from each household in society X, while each household in society Z is at a larger distance from each household in $X : d(X, Z) = d(Z, X) > d(X, Y)$. Households in 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. In general, we assume that $\sum_{k=X,Y,Z} \max\{0, [1 - \beta d(Y, k)]\}M_{kt-1} \geq \mu_i$ and $\sum_{k=X,Y,Z} \max\{0, [1 - \beta d(Z, k)]\}M_{kt-1} \geq \mu_i$. For simplicity, we assume prohibitive barriers between society Y and Z: $\beta d(Y, Z) \geq 1$.

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 must observe a much larger mass of modern households before changing their own attitudes. In each society, $\mu_i' s$ are distributed uniformly over the continuum of households, between a minimum $\mu_L \geq 0$ and a maximum $\mu_H > \mu_L$.[32] For simplicity, we assume that such threshold distributions are identical in Y and Z.

We can now derive the dynamics of diffusion of new social norms within and across societies.[33] At time 0, only the innovator society has adopted the new social norms and therefore $M_{X0} = 1$,

[31] 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 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'.

[32] To allow for *any* spread of innovations across societies, we assume that the minimum threshold μ_L is not too high: $\mu_L < 1 - \beta d(X, Y)$.

[33] This process can be interpreted in terms of cultural transmission across and within generations (Richerson and Boyd, 2005). At time t, households inherit the norms shared by their previous 'incarnation' at time $t - 1$, which can be interpreted as vertical transmission from one generation to the next. However, each household may also discard those inherited norms and adopt new norms, transmitted horizontally or obliquely—that is, from people who are not direct ancestors of the adopters. An extension would be to model the decisions by current households to invest in the transmission of vertically transmitted traits (including attitudes towards fertility control) to *future* generations, to influence the likelihood that future households may retain traditional norms or adopt new norms, as in Bisin and Verdier (2001). Interestingly, the transmission of new norms to future generations could be 'maladaptive' in a Darwinian sense, which

$M_{Y0} = M_{Z0} = 0$. At time 1, the new social norms are adopted by all households in society Y for whom 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:

$$\mu_i \leq [1 - \beta d(X, Y)]M_{X0} = 1 - \beta d(X, Y). \tag{6}$$

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

$$M_{Y1} = \min\left\{\frac{1 - \beta d(X, Y)}{\mu_H - \mu_L}, 1\right\}. \tag{7}$$

In society Z two cases are possible. For $\mu_L \geq 1 - \beta d(X, Z)$, 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:

$$M_{Z1} = \min\left\{\frac{1 - \beta d(X, Z)}{\mu_H - \mu_L}, 1\right\}. \tag{8}$$

At time 1, average fertility in society $k = Y, Z$ is $f_{j1} = M_{j1} f_m + (1 - M_{j1}) f_n$, where $f_m \equiv (b + \sigma_1)/c < f_n$. In the rest of the analysis, we abstract from polar cases and focus on the intermediate range of parameters for which some (but not all) households in Z adopt the novel behaviour at time 1.[34] At time 2, in Y the new norms are adopted by all households for which $\mu_i \leq 1 - \beta d(X, Y) + \frac{1-\beta d(X,Y)}{\mu_H-\mu_L}$, implying the following number of modern households in Y at time 2:

$$M_{Y2} = \min\left\{\frac{1}{\mu_H - \mu_L}\left[1 - \beta d(X, Y) + \frac{1 - \beta d(X, Y)}{\mu_H - \mu_L}\right], 1\right\}, \tag{9}$$

and so on as t increases. Analogous relations hold in society Z. Without much loss of generality, we assume $\mu_H - \mu_L = 1$. M_{Yt} and M_{Zt} can then be written as $M_{kt} = \min\{t[1 - \beta d(X, k)], 1\}$, where $k = Y, Z$.

We can now study the relationship between social distance and the dynamics of the diffusion of novel fertility behaviour. Let $M^{\#}$ denote the fraction of modern households such that average fertility is $f^{\#} < f_n$, that is, $f^{\#} = M^{\#} f_m + (1 - M^{\#}) f_n$. Let $T(f^{\#})$ denote the *earliest* time at which $f^{\#}$ is achieved. $T(f^{\#})$ occurs earlier for society Y at distance $d(X, Y)$ than for society Z at distance $d(X, Z) > d(X, Y)$:

$$T_Y(f^{\#}) < T_z(f^{\#}). \tag{10}$$

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, the time when a society at social distance $d(k, X)$ reaches $M^{\#}$ with fertility $f^{\#}$ is

$$T_k(f^{\#}) = \frac{M^{\#}}{1 - \beta d(k, X)}. \tag{11}$$

may explain why the transmission of modern fertility behaviour occurred horizontally rather than vertically (Newson *et al.*, 2005; Newson and Richerson, 2009).

[34] That is, $\mu_L < 1 - \beta d(X, Z) < \mu_H$. 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 $M_{Y1} = M_{Z1} = 1$ ($\mu_H \leq 1 - \beta d(X, Z)$).

A society at distance $d(k, X)$ achieves full modernisation ($M^{\#} = 1$ and average fertility equal to f_m) at

$$T_k(f_m) = \frac{1}{1 - \beta d(k, X)}. \tag{12}$$

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.

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 behaviour, becomes higher over time, and falls again in the latest stages of the fertility transition.*[35]

Another way to capture the changing relation between fertility and social distance from the innovator is in terms of correlations between levels of fertility and distances at different points in time.[36]

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. 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 $t \geq T^e$. This can be summarised 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.*

3. 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

[35] See the Online Appendix for a numerical illustration.

[36] E.g., assume $f_m = 1$, $f_n = 3$ and $\beta = 1$. 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 decreases to $\rho = 0.95$, as fertility rates in societies Y and Z go to 5/3 and 11/5. Then, 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. 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 $f_m = 1$. Technically, at time 5 the correlation between fertility levels and distances is undefined because the fertility rate's standard deviation is zero. The correlation would be equal to 0 if we slightly extend the model to allow for a small variation in modern fertility ($f_m = 1 + \varepsilon$, where ε is a random variable with zero mean and a very small but positive variance).

French) is related to the diffusion of the fertility decline across Europe, and characterise how this relationship changes over time. In doing so, we take care to control for variables capturing the intrinsic costs and benefits of fertility. Our approach is to check whether the patterns and correlations implied by the model hold in the data.

We explore three predictions of the model, corresponding to its three propositions. We first examine whether the fertility transition started earlier in regions at lower social distances from the French (Proposition 1). Second, we examine whether the probability of having experienced the fertility transition was lower for populations or regions at a greater distance from the French and how this relationship changed through time (Proposition 2). Third, we analyse the determinants of the level of marital fertility (I_g) itself, over time, focusing on social distance from the French (Proposition 3). We use two data sets, the main one comprised of 775 sub-national regions of Europe and the other covering 37 European populations. We focus here on the regional data set. Both a description of the population-level data set and the corresponding empirical results appear in the Online Appendix.

3.1. *Summary Statistics*

Summary statistics for the regional data set are presented in Table 1. 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 1, we see that the fertility transition date is positively correlated with linguistic distance to French ($\rho = 0.54$).[37] Similarly, the level of marital fertility (I_g) is highly correlated with linguistic distance to French in early periods, but this correlation declines in later periods as more and more regions undergo the transition, consistent with our diffusion model.

3.2. *Determinants of the Transition Date*

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

$$FTD_{jc} = \delta_1 LD^f_{jc} + X'_{jc}\delta_2 + \alpha_c + \varepsilon_{jc}, \tag{13}$$

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. 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 dummies are defined using 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 urbanisation rate in 1850, population density in the mid-nineteenth century (a proxy

[37] The relationship between linguistic distance to French and the transition date is displayed graphically in the Binscatter plots of Figures A7 and A8 in the Online Appendix, respectively, without and with controls for geographic distance to French.

Table 1. *Summary Statistics for the Regional-Level Data set.*

Panel A: Means and standard deviations for the main variables of interest

Variable	No. Obs.	Mean	SD	Min.	Max.
Marital fertility transition date	771	1,899	24.989	1,830	1,945
Difference in linguistic nodes to French	775	7.409	3.032	0	10
Geodesic distance to Paris (km)	775	1,110	715	0	3,977
I_g(1831–1860)	184	0.623	0.136	0.321	0.972
I_g (1861–1890)	609	0.664	0.123	0.271	1.001
I_g (1891–1920)	675	0.594	0.129	0.225	0.914
I_g (1921–1950)	766	0.421	0.121	0.086	0.763
I_g (1951–1970)	706	0.336	0.097	0.129	0.714

Panel B: Simple correlations among the main variables of interest

	I_g 1831–1860	I_g 1861–1890	I_g 1891–1920	I_g 1921–1950	I_g 1951–1970	Marital fertility transition date	Difference in linguistic nodes to French
Difference in linguistic nodes to French	0.724	0.522	0.525	0.210	−0.070	0.538	1
Geodesic distance to Paris (km)	0.366	0.088	0.399	0.491	−0.042	0.541	0.382
No. of observations	184	609	675	766	706	771	775

Notes: There are four regions with I_g 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).

for technological advancement in Malthusian times), the literacy rate in 1880 and proximity to coalfields.[38]

3.2.1. *Baseline results*

Table 2 presents the baseline results considering distance to the French language (for linguistic distance) and to Paris (for geographic distance).[39] 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 standardised effect of linguistic distance equal to 26.83%.[40] 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, 2019). Finally, the effect of linguistic distance to French remains robust when we include controls for distance to coalfields, population density, urbanisation and literacy. These variables take on negative signs. This is as expected, because more urbanised, more industrialised, denser, and more literate regions face a lower ratio of intrinsic benefits to costs of children. However, two of the four variables, including distance to coalfields, do not bear statistically significant coefficients, and only one of them (urbanisation) remains statistically significant at the 10% level when all four are entered jointly (column 7).

These baseline results are particularly noteworthy in light of the inclusion of country fixed effects, a stringent test of our hypothesis as it requires identification from within-country, cross-regional variation.[41]

3.2.2. *Horse race with English.*

Table 3 runs a horse race between the distance to English/London and the distance to French/Paris, again with country fixed effects. The goal is to assess the robustness of our main effect to the inclusion of distance to the birthplace of the Industrial Revolution. To do so, we include linguistic distance to English and geographic distance to London in the specification of equation (13). We find that, regardless of the included set of control variables, the effect of linguistic distance to French on the transition date is positive, significant, and its standardised magnitude varies

[38] The proximity to coalfields is measured as the distance from a region's centroid to the centroid of the closest coal polygon (Fernihough and O'Rourke, 2021). The results do not change when using alternative measures of proximity to coal, such as distance to the closest point in a coal polygon or the minimum distance to a polygon of carboniferous rock strata, rather than an actual coalfield.

[39] 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.

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

[41] In the Online 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 data set. 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 data set. The Online Appendix describes these results in detail.

Table 2. *Cross-Regional Regressions for the Marital Fertility Transition Date, with Country Fixed Effects.*

	(Dependent variable: marital fertility transition date)						
	(1) Univariate	(2) Control for geography	(3) Control for distance to coal	(4) Control for literacy	(5) Control for pop. density	(6) Control for urbanisation	(7) Control for everything
No. of different nodes with French	2.260	2.207	2.191	3.185	2.461	2.734	3.905
	(5.50)***	(5.25)***	(5.21)***	(8.63)***	(3.61)***	(4.09)***	(6.04)***
Geodesic distance to Paris, km		−0.0001	−0.001	−0.029	−0.007	−0.012	−0.041
		(0.02)	(0.17)	(1.77)*	(0.88)	(1.24)	(2.18)**
Distance to closest coal centroid (km)			−0.003				−0.005
			(0.70)				(0.49)
Literacy rate, 1880				−0.055			−0.064
				(0.89)			(0.77)
Population density, mid-nineteenth century					−0.098		−0.008
					(3.08)***		(0.21)
Urbanisation rate, 1850						−11.700	−9.693
						(3.01)***	(1.68)*
R^2	0.70	0.72	0.72	0.75	0.72	0.75	0.77
No. of regions (no. of countries, 1846 borders)	771	771	768	413	556	438	296
	(25)	(25)	(25)	(9)	(20)	(21)	(7)
Standardised beta (%)	27.468	26.830	26.660	39.220	27.962	30.911	43.278

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. All specifications include an intercept term.

Table 3. *Cross-Regional Regressions, English–French Horse Race, with Country Fixed Effects.*

	(Dependent variable: marital fertility transition date)			
	(1) Univariate	(2) Control for all distances	(3) Control for micro-geography	(4) Control for intrinsic determinants
No. of different nodes with French	2.122	2.175	2.286	3.747
	(5.09)***	(5.23)***	(5.41)***	(5.75)***
No. of different nodes with English	1.528	1.513	2.016	−0.033
	(1.96)*	(1.89)*	(2.45)**	(0.02)
Geodesic distance to London, km	−0.026	−0.044	−0.051	−0.082
	(2.10)**	(2.66)***	(2.98)***	(2.76)***
Geodesic distance to Paris, km	0.034	0.043	0.053	0.030
	(3.01)***	(2.44)**	(2.87)***	(0.74)
Distance to closest coal centroid (km)				−0.010
				(0.93)
Literacy rate, 1880				−0.092
				(1.12)
Population density, mid-nineteenth century				0.018
				(0.46)
Urbanisation rate, 1850				−10.616
				(1.88)*
R^2	0.72	0.72	0.73	0.77
No. of regions	771	771	771	296
Standardised beta, English (%)	7.401	7.330	9.762	−0.130
Standardised beta, French (%)	25.790	26.435	27.787	41.528

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. All specifications include an intercept term. 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, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Spain, Sweden, Switzerland, Yugoslavia.

between 26% and 41%. In contrast, the effect of linguistic distance to English is often statistically insignificant and is always small in magnitude. Notably, these inferences hold in column (4), where we control for variables capturing the intrinsic costs and benefits of fertility choice and where linguistic distance from English bears a negative and insignificant coefficient. In sum, linguistic distance to French wins in a horse race with linguistic distance to English, indicating that the diffusion process stemmed from France not England.[42] Along with our results on the effect of distance to coalfields, this finding casts doubt on the view that the marital fertility

[42] Basso and Cuberes (2017) 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 behaviour, France, where economic modernisation came late relative to the UK, the birthplace of the modern Industrial Revolution. Hence, in contrast with the conclusions in Basso and Cuberes (2017), 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.

transition was primarily a by-product of industrialisation, a process in which England played a pioneering role.[43]

3.2.3. *Horse race with other languages*

A more systematic way to assess the robustness of distance to French is to conduct additional horse races with other languages/regions. We chose the capital regions of each of the 25 countries in our sample. We excluded Belgium (Brussels) and France (Paris region) because both regions are matched to the French language. We then ran the specification of (13), adding the geodesic and linguistic distance to each corresponding capital region. This generalises the exercise presented above with England/London to a broader set of possibly confounding linguistic and geographic distances to other possible innovator regions. The results appear in Figures 2a and 2b. Figure 2a displays the coefficients on linguistic distance to each of the 23 capital regions, ordered by their size. In about half the cases, the estimated coefficient is negative. It is only significant and positive in four cases, all of them variations of a Germanic language (Luxembourgish, Viennese German, Insular Danish and High Alemannic). Most importantly, the inclusion of these distances does not affect the coefficient on linguistic distance to French very much: Figure 2b shows that in *all* 23 cases it remains positive, significant and of a magnitude comparable to that in the baseline estimates of Table 2. This is particularly the case for the few instances where the coefficient on the other linguistic distance was found to be positive and significant.[44]

3.3. *Determinants of Transition Status*

We now seek to understand the dynamics of the fertility transition better by 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:

$$T_{jct} = \gamma_0 + \gamma_1 LD^f_{jc} + X'_{jc}\gamma_2 + \varepsilon_{jct}. \tag{14}$$

The analysis of the transition status has two limitations: (a) We no longer include country fixed effects: since at a given date all or none of 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.[45] (b) We include a smaller set of covariates, excluding the geographic dummy variables, but maintaining

[43] We also replicated the same horse race, but between distance to German/Berlin and distance to French/Paris. This is to assess if perhaps the new fertility behaviour might have diffused from Germany (for instance, because that country was a leader in terms of literacy and human capital). The results appear in Table A18 of the Online Appendix. 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.

[44] These results can be generalised yet again by adding controls for geodesic and linguistic distances to each region in the sample, other than those that speak French. The results are reported in Figures A9 and A10 in the Online Appendix. In no instance, among 699 regressions, does distance to French become statistically insignificant as a result of the inclusion of these other linguistic/geodesic distances. In 98 cases (14%), the coefficient on the other linguistic distance is also positive and significant, although with usually small magnitudes. The positive and significant coefficients tend to be on distance to dialects of German like Alemannic, Jutlandic and Bavarian.

[45] 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.

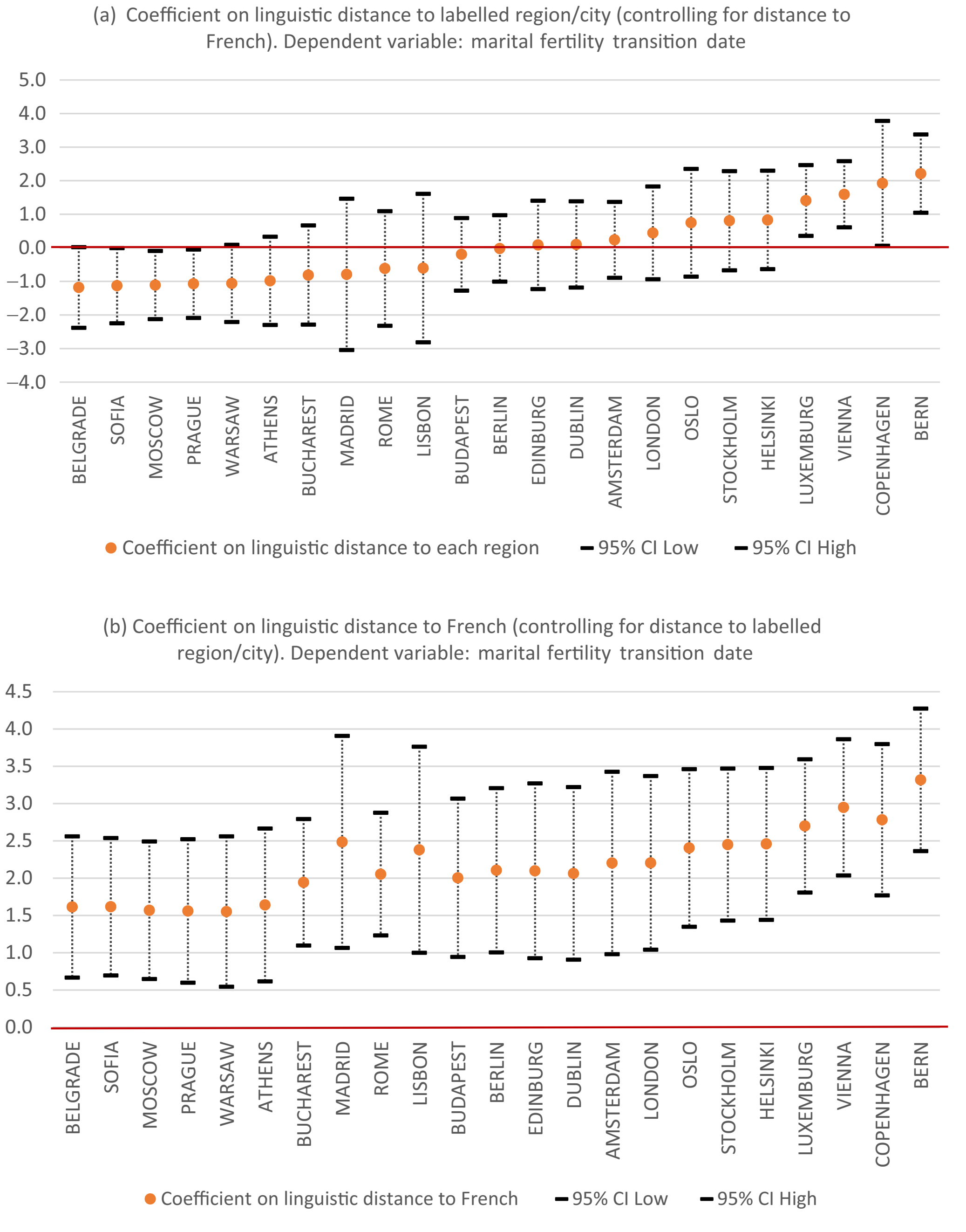

Fig. 2. *Controlling for Linguistic Distance to Alternative Major Cities (Dependent Variable: Marital Fertility Transition Date).*

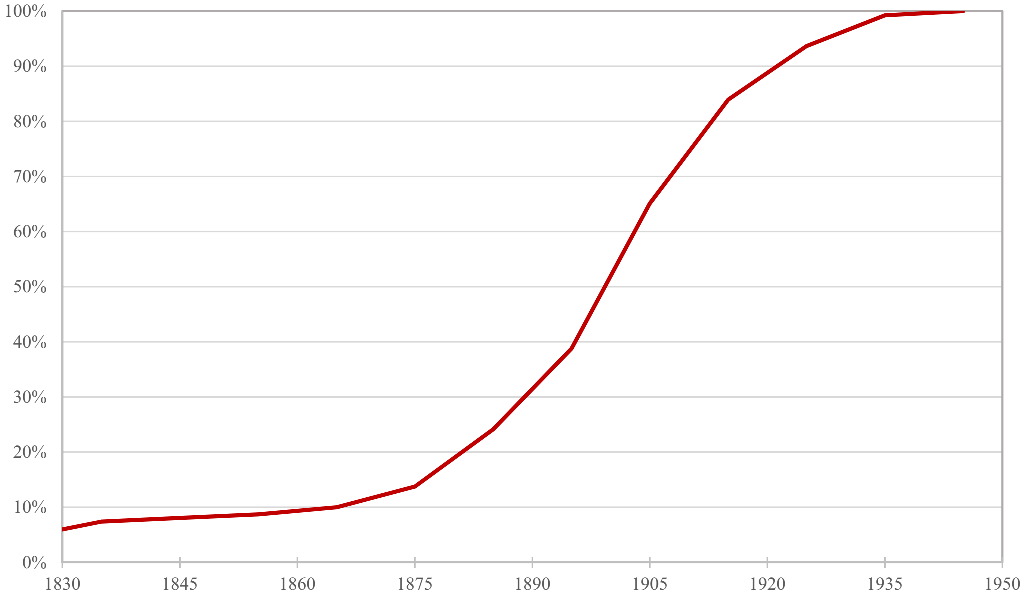

Fig. 3. *Cumulative Distribution of Fertility Transition Dates.*

the geographic distance measures. The reason is the same as before: for some periods, some dummy variables perfectly predict the outcome and the corresponding observations must be dropped, resulting in smaller samples. Given that 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.

3.3.1. *Shape of the adoption curve*

We begin by displaying graphically the cumulative share of regions for which T_{jct} takes on a value of 1, among the 771 regions with available data on the transition date (Figure 3). 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 data set 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 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

Table 4. *Probit Regressions for Fertility Transition Status.*

	(Dependent variable: fertility transition status indicator)					
	(1) 1841	(2) 1861	(3) 1881	(4) 1901	(5) 1921	(6) 1941
No. of different nodes with French	−0.00001	−0.008	−0.024	−0.022	0.017	0.001
	(0.19)	(2.79)***	(5.45)***	(3.03)***	(3.57)***	(1.07)
Geodesic distance to Paris, 1,000 km	0.0001	0.090	−0.027	−1.032	0.186	0.003
	(0.15)	(2.09)**	(0.25)	(4.78)***	(1.83)*	(0.34)
Absolute difference in longitudes to Paris	−0.0002	−7.494	−3.259	27.098	−22.048	−0.082
	(0.19)	(2.71)***	(0.49)	(2.05)**	(3.40)***	(0.15)
Absolute difference in latitudes to Paris	−0.0001	−9.711	−12.016	48.144	−29.674	−0.980
	(0.15)	(2.46)**	(1.48)	(3.02)***	(4.21)***	(1.20)
Pseudo R^2	0.61	0.47	0.41	0.32	0.20	0.17
Standardised effect of linguistic distance to French (%)	−0.001	−27.383	−53.164	−17.498	6.134	0.201

Notes: t-statistics in parentheses: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. The dependent variable for year t is defined as 1 and is a region that 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 standardised effect is equal to the probit marginal effect multiplied by the standard deviation of linguistic distance to French, 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, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Spain, Sweden, Switzerland, Yugoslavia.

(Young, 2009, p. 1901). Thus, pure inertia cannot explain the logistic curve that characterises the adoption of modern fertility behaviour.

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 50% 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 behaviour is gradually adopted by different agents through mechanisms of social influence (consistent with our theoretical framework) and/or social learning.

3.3.2. *Probit results*

Results from estimating (14) using probit are presented in Table 4, at 20-year intervals from 1841 to 1941, a century 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 standardised magnitude rises to 53% in 1881 before declining thereafter and becoming insignificant in 1941.[46] This corresponds to the prediction of Proposition 2. We find a similar pattern when controlling for the literacy rate, distance to coalfields, the urbanisation rate and population density (Table A8 in the Online Appendix), despite a much smaller sample of only 296 regions from 8 countries.

For a more complete view of the dynamics of the transition, Figure 4 displays graphically the time path of the standardised effect of the linguistic distance from French, estimated at every

[46] Here, our measure of standardised 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.

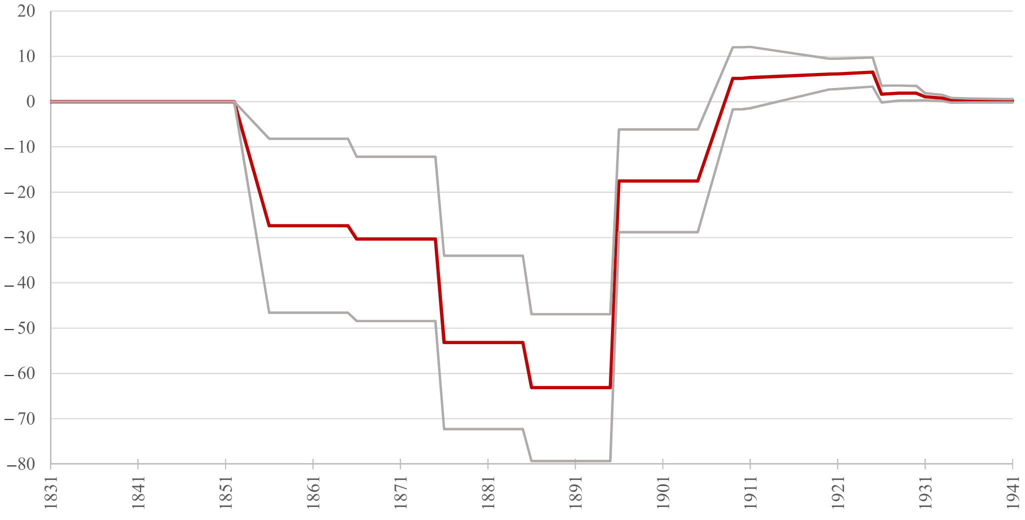

Fig. 4. *Standardised Effect of Linguistic Distance to French on the Probability of Having Experienced the Fertility Transition (95% CI in Grey). This chart depicts the standardised effect of linguistic distance to French on the probability of having experienced the fertility transition, defined by a 10% decline in I_g, 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.*

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 a lower probability of starting the marital fertility transition), with the standardised effect peaking at −63.13% in the 1886–1895 decade. 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.

3.4. *Determinants of I_g*

We now come to the central step in our analysis: we directly estimate the determinants of the level of marital fertility (I_g), i.e., we test 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 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:

$$Ig_{jc\tau} = \eta_1 LD^f_{jc} + X'_{jc}\eta_2 + \alpha_c + \varepsilon_{jc\tau}, \tag{15}$$

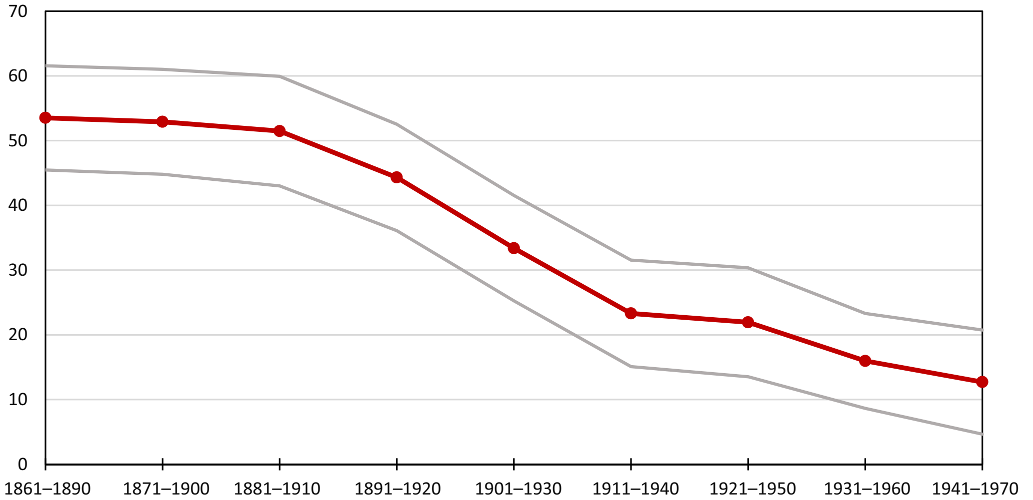

Fig. 5. *Standardised Effect of Linguistic Distance to French on I_g (%), Common Sample (95% CI in Grey; 30 Year Bandwidth). This chart shows the standardised effect of linguistic distance to French on marital fertility (I_g) through time, in overlapping samples of 30 years depicted on the x-axis. The sample is a balanced sample of 519 European regions.*

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.[47]

3.4.1. *Time path of the effect*

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 French 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 standardised 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 French adopt new fertility behaviour, consistent with Proposition 3.[48]

Figure 5 displays the same effect through time for a smaller set of 519 regions, estimated from

[47] Tables A6 and A7 in the Online Appendix show the corresponding empirical estimates of the determinants of I_g, obtained from the population-level data set, 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 data set. The Online Appendix describes these results in detail.

[48] In Table A9 in the Online Appendix, we augment the specification of (15) 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 standardised magnitude than linguistic distance to France. This result is consistent with the extension to our theory, also shown in the Online Appendix, where regions can be influenced by both the innovation frontier (France) and also by other regions that have experienced the fertility transition.

Table 5. *Cross-Regional Regressions for I_g Through Time, with Country Fixed Effects.*

	(Dependent variable: index of marital fertility, I_g)					
	(1) Period 1	(2) Period 3	(3) Period 5	(4) Period 7	(5) Period 9	(6) Period 11
No. of different nodes with French	14.867	21.364	20.502	18.391	11.378	6.417
	(4.35)***	(12.76)***	(11.84)***	(9.76)***	(6.54)***	(4.42)***
Geodesic distance to Paris, km	0.118	0.051	−0.007	0.007	−0.013	−0.024
	(0.45)	(0.78)	(0.11)	(0.11)	(0.39)	(0.84)
R^2	0.69	0.69	0.62	0.59	0.64	0.64
No. of regions (no. of countries, 1946 borders)	184	531	659	675	766	748
	(5)	(20)	(24)	(25)	(25)	(24)
Standardised beta on linguistic distance from France (%)	41.784	54.891	50.009	42.581	25.036	16.321
Standardised beta (%), common sample of 630 regions[a]	–	–	49.668	42.642	25.711	16.096

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. All specifications include an intercept term. Country fixed effects are period-specific due to changing borders. I_g 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, Czechoslovakia, Finland, Germany, Hungary, Ireland, Italy, Norway, Poland, Romania, Russia, Scotland, Sweden, Yugoslavia; column (3): as in column (2) plus Greece, Luxembourg, Portugal, Spain; columns (4) and (5): as in column (3) plus Bulgaria; and column (6): as in columns (4) and (5) minus Czechoslovakia.

[a] Common sample of 630 regions from the following 23 countries: Austria, Luxembourg, Belgium, Denmark, England and Wales, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Spain, Sweden, Switzerland, Yugoslavia.

the same specification in (15), for periods 4–12.[49] The standardised effect is slower to decay to zero than in the probit regressions of the preceding sub-section, 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 behaviour 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.

3.4.2. *Controlling for the intrinsic costs and benefits of fertility choices*

In Table 6, we augment the specification of (15) by including five additional controls for infant mortality (time varying), distance to the closest coalfield, population density (mid-nineteenth century), the urbanisation 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.[50] This is also a period relatively close to the time when urbanisation, population density and literacy are measured. Across the specifications of Table 6, the standardised beta on linguistic distance to French remains in line with the baseline estimate: it ranges from 36% to 62% depending on the specification, with variation mostly driven by changes in sample composition.

We also find a significant role for 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; Tamura, 2006) and the standardised effect of infant mortality is 11%. In column (2), distance to the closest coalfield bears a positive coefficient that is significant at the 10% level with a standardised magnitude of 8.4%.[51] This indicates that locations close to coalfields (and thus more likely to experience early industrialisation) tended to have lower levels of fertility. In column (3), we see that higher population density is associated with lower fertility, as would be expected if population density is a proxy for technological advancement, with a standardised beta of 11%. In column (4), a similar result is obtained for more urbanised regions—the standardised effect of the urbanisation rate being equal to 13%. In column (5) we find a negative and significant effect of the literacy rate on marital fertility (with a standardised beta of 12%), echoing the significant negative effect of human capital on fertility often documented in the literature (Galor, 2011, ch. 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.

[49] We display estimates for these nine 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.

[50] Tables A10–A17 in the Online Appendix replicate each column of Table 6 for all odd-numbered time periods. All these show a declining standardised effect of linguistic distance from French on the marital fertility index as time goes by, even in demanding specifications where several controls are introduced at once and, as a result, only a small share of the original sample of regions remains (for example, see Table A17 in the Online Appendix). The effects of infant mortality, distance to coalfields, urbanisation, 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.

[51] Throughout, we used the distance from a region's centroid to the closest centroid of a coal field polygon. The results obtained with this variable are very similar to those obtained using alternative definitions of distance to coal resources: the distance to the closest point in a coal polygon (as opposed to the closest polygon centroid), the distance to the centroid of a carboniferous-era rock strata polygon (geologic formations likely to contain exploitable coal), or the distance to the closest point in a carboniferous-era rock strata. The last two variables are possibly more exogenous than distance to an actual coalfield. Indeed, they capture the *potential* for coal exploitation rather than *actual* coal extraction. Table A18 in the Online Appendix uses these alternative measures, showing that their effects on marital fertility differ little and that the choice of measure does not affect the estimate on linguistic distance to French.

Table 6. I_g *Regressions with Country Fixed Effects and Additional Controls, Period 5 (1871–1900).*

	(Dependent variable: index of marital fertility, I_g)						
	(1) Infant mortality	(2) Distance to coal	(3) Population density	(4) Urbanisation rate	(5) Literacy	(6) All but infant mortality	(7) All additional controls
No. of different nodes with French	22.907	20.558	14.870	14.825	25.538	19.351	25.215
	(8.93)***	(11.87)***	(6.54)***	(6.03)***	(12.89)***	(6.61)***	(5.06)***
Geodesic distance to Paris, km	0.076	−0.025	−0.048	−0.017	−0.135	−0.088	−0.151
	(0.49)	(0.43)	(0.75)	(0.21)	(1.76)*	(0.96)	(0.79)
Infant mortality rate	353.710						522.969
	(2.15)**						(2.34)**
Distance to closest coal centroid (km)		0.049				−0.060	−0.223
		(1.89)*				(0.95)	(1.70)*
Population density at mid-nineteenth century			−0.015			−0.009	−0.005
			(3.57)***			(1.85)*	(0.81)
Urbanisation rate in 1850 (Bairoch)				−98.770		−63.692	−134.400
				(4.60)***		(2.14)**	(2.66)***
Literacy rate in 1880					−0.720	−0.577	−1.084
					(2.32)**	(1.45)	(1.51)
R^2	0.61	0.62	0.64	0.66	0.68	0.67	0.67
No. of regions	285	656	519	401	408	295	176
Standardised beta (%)	57.338	50.122	36.292	36.277	61.714	47.255	62.714

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. All specifications include an intercept term. Country fixed effects are defined as per 1886 political borders. In terms of 1946 borders, countries to which regions in the sample belong are as follows: column (1): Belgium, Denmark, England and Wales, France, Germany, Switzerland; column (2): Austria, Belgium, Denmark, England and Wales, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Scotland, Spain, Sweden, Switzerland, Yugoslavia; columns (3) and (4): Austria, England and Wales, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Scotland, Spain, Sweden, Switzerland; column (5): Austria, Belgium, England and Wales, France, Germany, Hungary, Italy, Spain; column (6): Austria, England and Wales, France, Germany, Hungary, Italy, Spain; and column (7): England and Wales, France, Germany.

3.4.3. *The role of family types*

Besides linguistic distance from France, other cultural features of societies could affect fertility levels across the regions of Europe at various points during the fertility transition. To some extent, the inclusion of country fixed effects may capture these factors. However, if there is within-country variation in culture, other historically inherited cultural features could be omitted variables in our regressions. Family types is one such feature that has been frequently studied. In a series of books, Emmanuel Todd (1985; 1990) pointed to family types, determined at least as far back as in medieval times, as important cultural characteristics of societies in Europe and around the world with persistent effects on socioeconomic outcomes today. He categorised family types along two dimensions. First, whether they are nuclear or stem families: the former refers to households that include mother, father and children, while the latter refers to extended households that include grandparents, aunts and uncles, and other family members. Second, whether the inheritance mode is egalitarian or whether some children (in particular, firstborn males) are advantaged. These two distinctions lead to the definition of five family types: egalitarian nuclear, absolute nuclear, stem family, incomplete stem family and communitarian (some regions have indeterminate family types).

We obtained data on the share of each of these family types in the regions of Europe from Duranton *et al.* (2009) and matched them to our regional nomenclature.[52] We then included these indicators of family type in our baseline regression explaining I_g. We have two goals: first, to establish robustness of the effect of linguistic distance to French; second, to investigate whether family type independently affects fertility levels across regions. The results are presented in Table A19 in the Online Appendix. We find that the inclusion of family type does not materially affect the coefficient on linguistic distance to France. We also find that family types have a significant impact on I_g. In particular, in every period, marital fertility is higher in regions with stem families. In sum, ancestrally inherited cultural features (family type) continued to have a significant effect on fertility rates at the very time when major changes in fertility behaviour across the regions of Europe were diffusing from the innovating country, France.

3.4.4. *Horse race with English*

In Table 7, we include all the geographic and linguistic distance variables not only relative to France/French but also relative to England/English, to conduct a horse race. 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 standardised effect of distance from French on I_g is 51.8% while the effect of linguistic distance from English is 6.8% and is statistically indistinguishable from zero. These results mirror 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. Instead, it was partly the result of a different cultural diffusion process starting from France.[53]

[52] The geographic coverage of this data set is mostly countries of western Europe where there is regional variation in family type. The sample consists of regions from Austria, Belgium, Denmark, England and Wales, France, Germany, Ireland, Italy, Netherlands, Portugal, Scotland and Spain. Todd (1985) also categorised family types in the regions of eastern Europe. However, for most of these countries, family type does not vary at the regional level.

[53] In Tables A20 and A21 in the Online Appendix, we conduct a similar horse race 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 standardised beta coefficient).

Table 7. *Regional Regressions for I_g, Horse Race with England, with Country Fixed Effects.*

	(Dependent variable: index of marital fertility, I_g)					
	(1) Period 1	(2) Period 3	(3) Period 5	(4) Period 7	(5) Period 9	(6) Period 11
No. of different nodes with French	16.131	22.106	21.221	20.013	12.587	8.100
	(4.29)***	(12.08)***	(11.60)***	(10.07)***	(6.76)***	
No. of different nodes with English	7.379	5.496	8.046	16.834	9.735	13.935
	(0.61)	(1.02)	(1.46)	(2.82)***	(1.69)*	(2.82)***
Geodesic distance to Paris, km	0.373	0.341	0.387	0.424	0.137	0.057
	(1.38)	(3.10)***	(3.78)***	(3.81)***	(1.54)	(0.77)
Geodesic distance to London, km	−0.839	−0.430	−0.464	−0.453	−0.172	−0.097
	(3.65)***	(4.16)***	(4.84)***	(4.33)***	(2.14)**	(1.45)
Constant	619.526	494.217	509.198	400.859	51.697	172.223
	(5.78)***	(11.51)***	(11.71)***	(8.59)***	(0.92)	(3.92)***
R^2	0.72	0.71	0.64	0.61	0.65	0.66
No. of regions	184	531	659	675	766	748
Standardised beta, linguistic distance to France (%)	45.338	56.799	51.763	46.336	27.696	20.600
Standardised beta, linguistic distance to England (%)	5.124	4.474	6.846	14.363	8.295	13.260

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. All specifications include an intercept term. Country fixed effects are period-specific due to changing borders. I_g was multiplied by 1,000 for readability of the estimates. In terms of their 1946 borders, countries to which regions belong are as follows: column (1): 5 countries: Denmark, England and Wales, France, Netherlands, Switzerland; column (2): 20 countries— countries in column (1) plus Austria, Belgium, Czechoslovakia, Finland, Germany, Hungary, Ireland, Italy, Norway, Poland, Romania, Russia, Scotland, Sweden, Yugoslavia; column (3): 24 countries— countries in column (2) plus Greece, Luxembourg, Portugal and Spain; columns (4) and (5): 25 countries—countries in column (3) plus Bulgaria; column (6): 24 countries—countries in columns (4) and (5) minus Czechoslovakia.

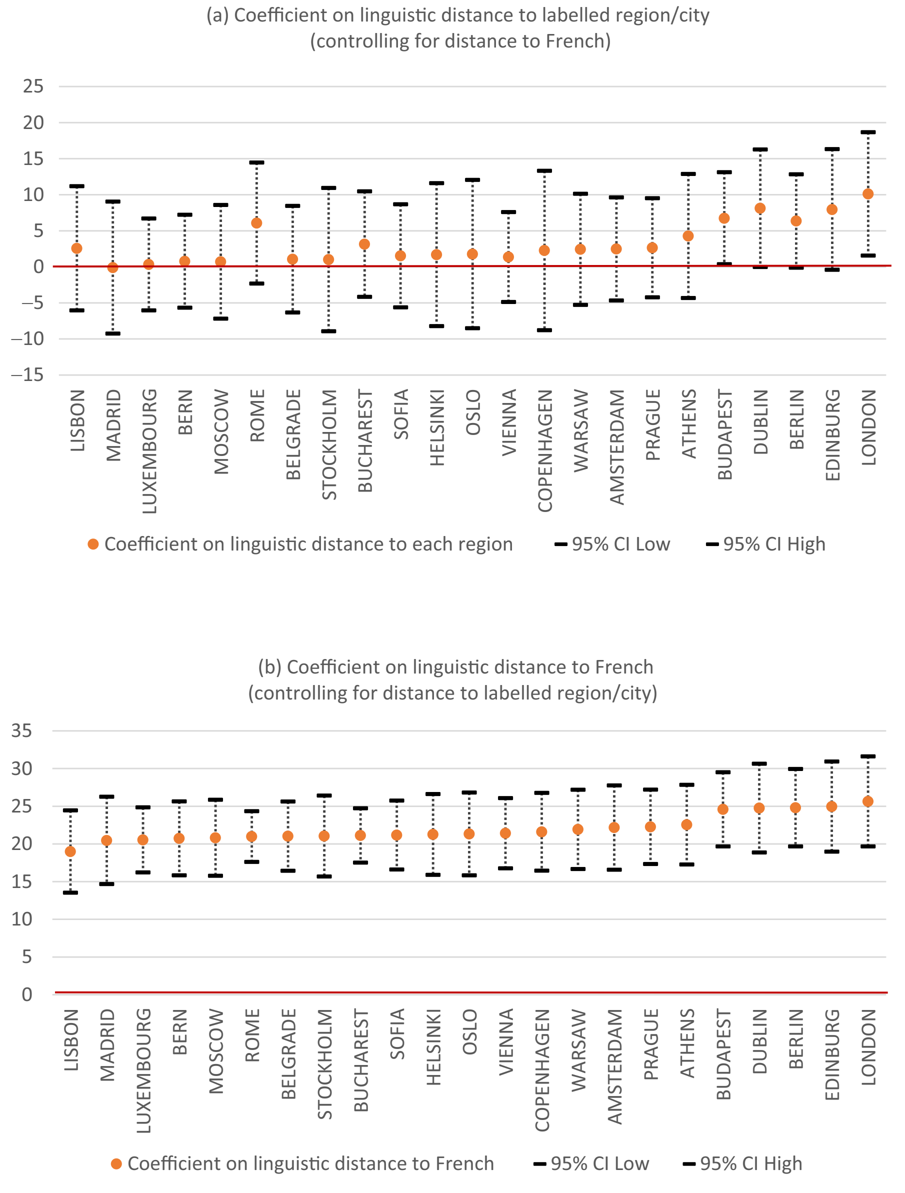

Fig. 6. *Controlling for Linguistic Distance to Alternative Major Cities (Dependent Variable: Marital Fertility Index, Period 5 (1871–1900)).*

3.4.5. *Horse race with other languages*

It is possible to conduct more systematic horse races by supplementing the specification of (15) using the geodesic and linguistic distances to other capital regions. We do so in a manner similar to that for the analysis of the fertility transition date, but using the index of marital fertility in period 5 (1871–1900) as the dependent variable. Figures 6a and 6b show the results for the 23 capital regions in our sample. The coefficients on linguistic distance to 21 of these capital regions are statistically indistinguishable from zero and also close to zero in magnitude (Figure 6a). The remaining two (to Budapest and London) are only barely significant. Notably, none of the capital regions that showed up with positive and significant signs in the analysis of the transition date do so in the marital fertility specification, suggesting these significant coefficients may have been spurious. In contrast, Figure 6b shows once again that the coefficient on linguistic distance to French, controlling for these alternative distances, remains significant and of a sizeable magnitude in all cases.[54]

3.4.6. *Additional robustness tests*

We conducted several robustness tests. First, we replicated Tables 5 and 6 controlling for the log of geodesic distance rather than its level (Online Appendix, Tables A22 and A23). This did not affect 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 (Online Appendix, Tables A24 and A25). 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 the inclusion of country fixed effects does not result in the loss of much relevant variation. Third, we excluded France from the sample, or the regions at a linguistic distance to France smaller than 3 (these were regions of northern France, some regions of Belgium and some regions of Switzerland), to see if the inclusion of France or French-speaking regions drive the results. France represents a large fraction of the sample and displays substantial within-country variation in linguistic distance, so diffusion within France (or within a set of regions linguistically close to French) could be driving our results. The estimates are presented in the Online Appendix, Table A26, using either the fertility transition date or the level of marital fertility in period 5 as dependent variables. Excluding the regions of France does reduce the magnitude of the effect of linguistic distance to France on the fertility transition date, but this effect remains positive and significant. Excluding France does not have a material effect in the regression explaining the level of marital fertility. Excluding regions at a low linguistic distance to French similarly has little impact on our baseline estimates for either dependent variable. Fourth, we checked for non-linear effects of linguistic distance to French, as well as interaction effects with our five measures of the intrinsic costs and benefits of fertility choices. We found no evidence of significant non-linear or interaction effects. Fifth, we tested whether the five proxies for the intrinsic costs and benefits of fertility choices diffused from France.[55] Results are reported in Table A27 in the Online Appendix. 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, urbanisation, literacy and distance to coalfields. Thus, there is little evidence

[54] Once again, a more systematic test is to add controls for geodesic and linguistic distances to each region in the sample, other than those that speak French. The results are reported in Figures A11 and A12 in the Online Appendix. Again, among 699 regressions, distance to French remains statistically significant in every single case, after the inclusion of these other linguistic/geodesic distances. In 79 cases (11.3%), the coefficient on the other linguistic distance is also positive and significant, although with usually small magnitudes. The positive and significant coefficients tend to be on distance to regions of England or Basque-speaking regions of Spain and France. In sum, we find little robust evidence that modern fertility patterns diffused from locations other than French-speaking ones, whereas we find systematic evidence that distance from French was a significant determinant of the cross-section of marital fertility at the height of the diffusion process.

[55] The specification is similar to that in (15), but the dependent variable is now infant mortality, population density, urbanisation, literacy and distance to coalfields. The specifications are single cross-sections of regions, with country fixed effects and geographic controls.

that these fertility-reducing variables diffused from France (of course, some may have diffused from another frontier).

4. Conclusion

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 was the central goal of this paper. By bringing in measures of cultural barriers along with economic variables, we aimed to bridge the gap between analyses of the demographic transition that emphasise cultural mechanisms and those that focus on economic incentives. Our conclusion is that, to understand the fertility decline in Europe, we need to consider *both* cultural and economic forces.

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 adoption of novel behaviour 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 predictions of our theoretical model using a novel data set of linguistic distances between European regions. We found that social distance from the innovator (France) is positively related with the fertility transition date across populations and regions, and positively related to the level of marital fertility in different periods. Moreover, the process of diffusion of the fertility transition matches 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 behaviour.

The diffusion of the fertility decline and the spread of industrialisation followed different patterns because societies at different 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, suggesting that cultural distance from the French does not capture the direct effect of persistent French cultural traits, but the effect of barriers to the cultural diffusion of knowledge and norms about fertility control. Overall, this paper provides evidence that the spread of new behaviour and values across cultural barriers was an important force behind the decline of fertility in Europe.

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Additional Supporting Information may be found in the online version of this article:

Online Appendix
Replication Package

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