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ABSTRACT

The Cultural Diffusion of the Fertility Transition: Evidence from Internal Migration in 19th Century France*

France experienced the demographic transition before richer and more educated countries. This paper offers a novel explanation for this puzzle that emphasizes the diffusion of culture and information through internal migration. It tests how migration affected fertility by building a decennial bilateral migration matrix between French regions for 1861-1911. The identification strategy uses exogenous variation in transportation costs resulting from the construction of railways. The results suggest the convergence towards low birth rates can be explained by the diffusion of low-fertility norms by migrants, especially by migrants to and from Paris.

JEL Classification: J13, N33, O15

Keywords: fertility, France, demographic transition, migration

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1. Introduction

France is usually viewed as an anomaly in studies dealing with the role of fertility decline in the transition from "Malthusian" to modern economic growth (see, e.g., Lee, 2003, Galor and Weil, 2000, Galor, 2005a, Galor, 2005b, Galor, 2012). This is because French birth rates already declined in the late 18th century, and the differences in the fertility rates across French regions disappeared in the course of the 19th century to reach a uniformly low level throughout the country before WWI (Cummins, 2013, Guinnane, 2011, Weir, 1994). Yet, France was a relative economic laggard vis-à-vis countries like England or the Netherlands in the 18th century and grew at a slower rate than England or Germany during the 19th century (Maddison 2001).

The factors which drove the rapid convergence towards low fertility rates across French regions during the 19th century are still debated.[1] There were, of course, changes in economic conditions, e.g., the rise in the demand for human capital which occurred during the second Industrial Revolution, the decline in child mortality or increased life expectancy. However studies on the demographic transition in France (e.g., Weir, 1994, Murphy, 2015) all suggest that such changes were probably not substantial and rapid enough to explain, on their own, the demographic transition.[2]

It is however possible that increased social interactions, which spread information and cultural norms, contributed to the convergence in fertility rates (Gonzalez-Baillon, 2008, Murphy, 2015, Spolaore and Wacziarg, 2014).[3] In this respect, two

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[1] An unsubstantiated explanation is that lower birth rates might have stemmed from the quick diffusion of contraceptive techniques which was criticized by the moralists of the day. On this issue, see Bergues et al. (1960) and Murphy (2015). Relatedly, Boyer and Williamson (1989) suggest that the fertility transition in England between 1851 and 1911 could be partly attributed to the diffusion of contraceptive techniques.

[2] For studies on the fertility decline and the decline in infant and child mortality, see e.g., Dupâquier and Poussou (1988), Eckstein et al. (1999) and Doepke (2005) for a different view. On the demand for human capital, see e.g., Galor and Weil (2000), Galor and Moav (2002), Hazan and Berdugo (2002), Becker et al. (2010, 2012), Klemp and Weisdorf (2012) and Vogl (2016). On increased life expectancy, see Galor (2012) as well as Hazan (2009) for a different view. On female labour participation, see, e.g., Doepke et al. (2015) and Hazan and Zoabi (2015). See also de la Croix and Perrin (2016) for a rational choice model of education and fertility in 19th c. France.

[3] Cultural norms are defined as preferences and beliefs that impact current economic behavior although they were developed at a different time and place (Fernandez 2007). Relatedly, Fernandez and Fogli

observations are noteworthy. First, it was in the course of the 19th century that France progressively developed a national culture, as reflected by the spread of French at the expense of regional languages (Weber, 1976).[4] Second, the French did not migrate to the New World during the 19th century but instead moved within France.[5] These two observations suggest that migration may have contributed to cultural harmonization within France, a conjecture which we directly address in this study by focusing on the decline in fertility.

This paper investigates whether the progressive regional convergence of fertility rates in France during the second half of the 19th century was fostered by the rise in internal migration which conveyed economic and cultural information.[6] For this purpose, it focuses on the specific patterns of internal migration between 1861 and 1911 between the French departments, i.e., the administrative divisions of the French territory which were established in 1790.[7]

Our study relies on the French Census and on the *Enquête des 3000 familles*

(2006) and Blau et al. (2011) show that the social norms of the source countries keep affecting the behaviour of second-generation immigrants, notably in matters of fertility. See David and Sanderson (1987), Fargues (2007), Bertoli and Marchetta (2015), Munshi and Myaux (2006), and specifically La Ferrara et al. (2012) on the role of norms in the fertility transition currently taking place in developing countries. See also Beine et al. (2013) who examine a cross-section of developing and developed countries during the 20th century and suggest that fertility choices in migrant-sending countries are influenced by diaspora networks that transfer of fertility norms prevailing in the host countries.

[4] Before the 19th century, a substantial share of the population did not speak French in regions like Brittany (in the West) or Provence (in the South) and this language barrier reflected further cultural and behavioural differences, including in matters of fertility (see also Braudel, 1986, vol. 1, pp. 88-94).

[5] See Hatton and Williamson (1998), Hatton (2010), as well as Abramitzky et al. (2013, 2014) and Bandiera et al. (2013) on international migration over the period considered in this paper (now commonly referred to as « the age of mass migration » -- but not for France).

[6] There is a growing literature documenting the role of migrants in the transmission of preferences, ideas and values. See, for example, Clinginsmith et al. (2009) on religious attitudes and Spilimbergo (2009), Docquier et al. (2016), Mercier and Chauvet (2014) and Barsbai et al. (2016) on political preferences. Instead, research on the impact of migration movements in 19th century France focused on the role of migrant networks on marriages (e.g. Bonneuil et al., 2008) or wealth transmission (e.g., Bourdieu et al., 2000) but did not analyze the possibility that internal migration may have contributed to the convergence in the fertility rates by conveying cultural norms.

[7] Departments were designed so that it would take at most one day by horse travel to reach the administrative center of the department from any location in the department. They were thus organized independently of fertility patterns and migratory movements in the 18th century.

(Survey of the 3000 Families), which provides information based on parish registers on the places of birth and death of all the individuals whose last name starts by the three letters "T", "R" and "A". These two datasets enable us to build a bilateral matrix of inter-regional migrations for the period 1861-1911 (Bourdelais, 2004, Bourdieu et al., 2004, Dupâquier, 2004) which we combine with the data on departmental fertility computed by Bonneuil (1997). We then assess the migrants' contribution to the demographic transition across France by constructing, for each department, the fertility norms of immigrants and emigrants as weighted averages of the fertility rates in the migrants' origin and destination department, in line with the approach of Spilimbergo (2007, 2009).

Our identification strategy relies on exogenous variations in the bilateral travel costs between the French departments that entailed a time-varying decrease in travel costs and had a positive effect on migration.[8] The choice of this instrumental variable is motivated by the historical development of the railroad network which the central government designed to connect Paris, the capital, to the main economic centers of France (Caron, 1997). There is indeed substantial anecdotal evidence, which is confirmed by our falsification tests, that the railroad network was developed independently from fertility patterns and migration choices.

Our results show that fertility declined more in areas that (i) had more emigration and (ii) whose migrants migrated towards (or migrated from) low-fertility regions, especially Paris. These results are robust to accounting for the potential confounding effects of factors such as declining child mortality, increased life expectancy, rising education, industrialization and religiosity levels. Our interpretation is that emigrants who moved from high- to low-fertility areas transmitted cultural and economic information about fertility norms and the cost of raising children in the regions where they had settled to the inhabitants of the regions where they came from. This information might have been then taken into account by actual and would-be emigrants, thus explaining why we find that departments with a larger share of

[8] The development of the railroad network might have fostered long-term and permanent migration, but also short-term migration. However it is not clear whether patterns of fertility decline can be attributed to short-term migration which had existed in France since the end of the Middle Ages and was motivated by the need for a temporary workforce during harvests. In fact, Châtelain (1976) documents that short-term migration began to decline in the second half of the 19th century, when long-term and permanent migration became more common.

emigrants experienced a larger drop in fertility. This interpretation is supported by our counterfactual analysis which shows that emigration to Paris, which accounted for 26.33% of the total number of French internal emigrants between 1861 and 1911, explains half of the national decline in fertility, in line with the economic, political and cultural importance of Paris within France. Finally, we note that child mortality is the only socio-economic variable which has a significant, albeit quantitatively limited, effect on the fertility decline while our robustness checks establish that other potential factors of information diffusion and cultural change, such as newspapers, the age at marriage or the number of children born out of wedlock, do not weaken the impact of migration on the decline in fertility.

The remainder of this article is as follows. Section 2 presents the data. Section 3 discusses the estimation strategy. Section 4 presents our main results and our robustness checks. Section 5 analyzes the channels for the informational transmission of the fertility decline. Section 6 concludes.

2. Data

Table A1 in the Supplementary Appendix provides descriptive statistics for our variables which are measured at the departmental level and cover the 1861-1911 period. Because of changes in the borders in the wake of the 1870-1871 French-Prussian war, France had 90 departments in 1861 and 87 after 1871. However, we restrict, for simplicity, our analysis to the departments which were part of France throughout the whole period.

2.1 Fertility rates

We measure fertility rates in each French department for every decade between 1861 and 1911. Specifically we use data from Bonneuil (1997) who provides values of the Coale (1969) Fertility Index in each department from 1806 to 1906 and which we extend to 1911 using data from the 1911 French census. The Coale Fertility Index controls for the demographic structure of the female population. It is based on the fertility levels of the Hutterites, a strict religious group in Northern America with a very high level of fertility. A childless population would have a Coale Fertility Index equal to zero and a population with the fertility rate of the Hutterites would have a Coale Fertility Index equal to one.

The Coale Fertility Index f is defined as:

$$f = (\sum_{k=1}^{K} F_k^t . W_k^t)/(\sum_{k=1}^{K} H_k . W_k^t) \quad (1)$$

where W_k^t is the number of women in age group k in year t, F_k^t is the rate of childbearing among women in the k^{th} age interval in year t and H_k represents the fertility rates observed for the Hutterites. In other words, the Coale Fertility Index f is the ratio of the number of observed births to the number of births if all women had Hutterite fertility.[9]

Bonneuil (1997) shows that, at the start of the 19th century, there were substantial differences in the fertility rates of the various departments that, presumably, reflected cultural and linguistic diversity within France (Weber, 1976, Braudel, 1986). In 1806, some departments already had low fertility rates: the Coale Fertility Index of *Calvados* (in the North-West of France) was equal to 0.246 while that of *Lot-et-Garonne* (in the South-West) was equal to 0.313. Conversely, the Coale Fertility Index of *Seine* (which comprised Paris and its immediate suburbs) was equal to 0.436 in 1806 but had already declined to 0.281 in 1851. In fact, the fertility of the average department declined from 0.408 in 1806 to 0.310 in 1851 while the standard deviation went from 0.107 in 1806 (26% of the mean) to 0.074 in 1851 (24% of the mean). This means that the decline in fertility during that period was relatively uniform in absolute terms across French departments, without any substantial convergence.[10]

It was only in the second half of the 19th century that regional differences in fertility disappeared: the average Coale fertility index of the French departments decreased from 0.310 in 1851 to 0.244 in 1911 while its standard deviation dropped from 0.074 (24% of the mean) to 0.038 (16% of the mean). There was thus a convergence in the fertility levels of the French departments between 1861 and 1911, as can be seen in Figure 1.[11] This is in contrast to what happened during the same time period in other European countries such as England & Wales, Germany, or Italy, as can be seen in Figures B1 to B4 in the Supplementary Appendix. This convergence in the regional fertility levels in France, unlike in England and Wales, Germany and

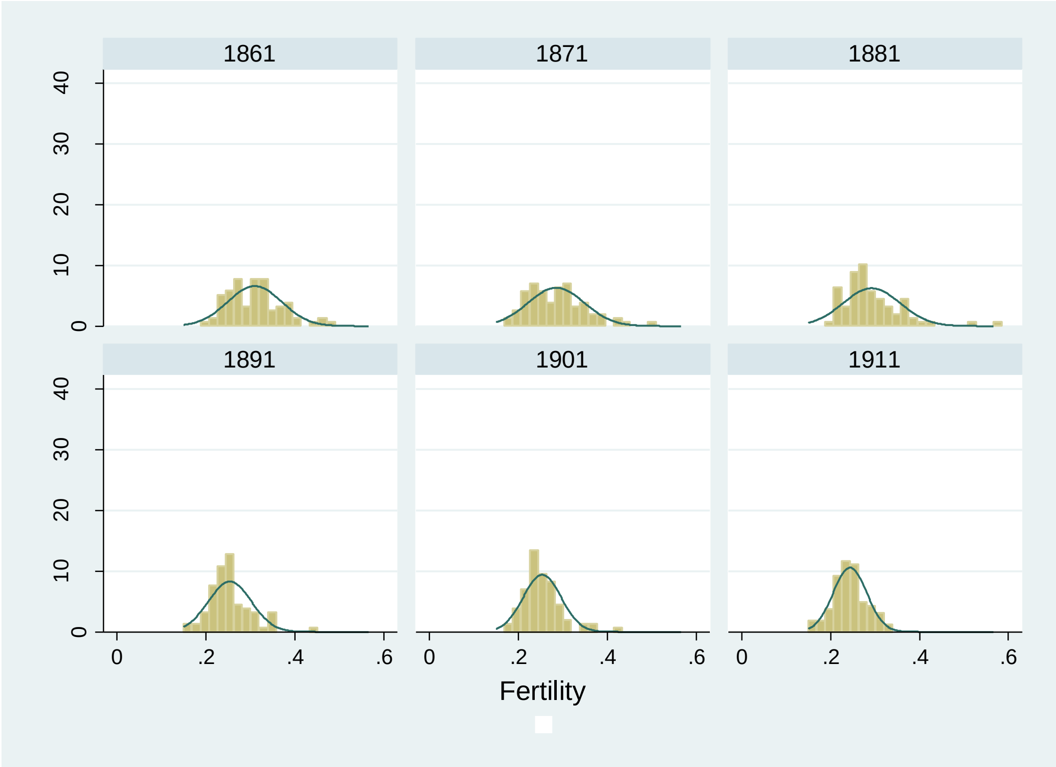
[9] The Coale Fertility Index in Bonneuil (1997) is a modified version of the usual Coale Fertility Index because it includes the fertility of all women and is not restricted to the fertility of married women.

[10] It is noteworthy, therefore, that Paris and its surroundings experienced a much more pronounced fertility decline than the other departments (from slightly above average in 1806 to below average in 1851).

[11] This convergence is not explained by a general decline of fertility bounded by zero and can still be observed when the logarithm of the fertility rate is considered.

Italy, is confirmed by the standard unconditional convergence regressions (Barro and Sala-i-Martin, 1992) which we report in Table C1 in the Supplementary Appendix.

Figure 1. Fertility across French departments, 1861-1911

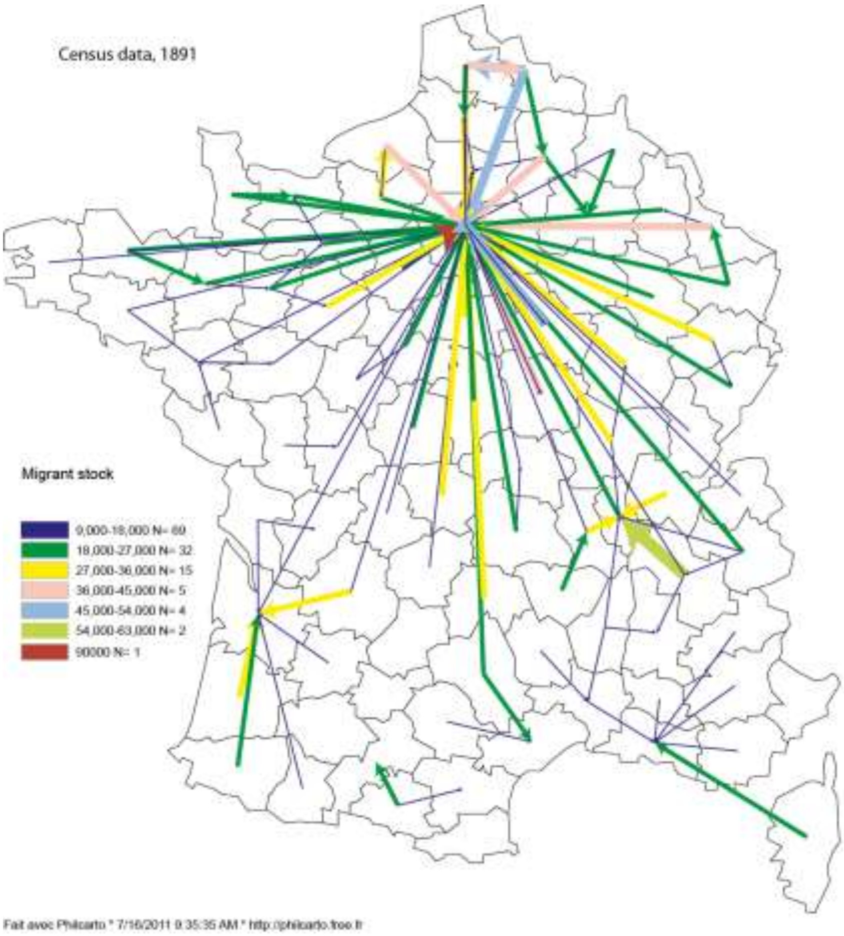


Source: (Bonneuil 1997) and authors' computations for 1911.

2.2 Migration in 19th century France

Our data on emigrants from, and immigrants to each French department between 1861 and 1911 stem from the TRA dataset, also known as the *Enquête des 3000 familles* (Survey of the 3000 Families) between 1861 and 1881. There may be concerns with the representativeness of the TRA dataset since it only provides information on the place of birth and death of all individuals whose surnames start by the three letters "T", "R" and "A" (Blanchet and Kessler, 1992, Bourdelais, 2004, Dupâquier, 2004). In the Supplementary Appendix, we show that we can reconstruct the geography of internal migration in France from the TRA data to the whole French population at the department level for the 1891-1911 period (for which the two datasets overlap) so as to alleviate concerns regarding the representativeness of the TRA dataset.[12]

Figure 2: Main bilateral migration corridors - 1891 Census data



Notes:

• For the sake of readability, this map does not report all the 7,832 observations (=89*88, as there are 89 *départements*) of the migrant stocks but only those which are larger than 10% of the largest stock, i.e., the 128 stocks larger than 9,000 (as the largest stock was formed by the 90,000 inhabitants of the *Seine département* born in the neighbouring *Seine-et-Oise département*).

• In the legend, the first two numbers represent the bounds of the bracket for the stock of migrants; N represents the number of links between *départements* in each bracket.

The data enable us to compute bilateral migration stocks which are defined as the number of people born in department i and living in department j in year t. They show that migrants moved from rural to urban areas as can be seen in Figure 2, where we

[12]Abramitzky et al. (2011) show that the TRA dataset is representative of the whole French population in their assessment of nuptiality patterns.

graph the migration patterns in France in 1891.[13] Many migrants moved to the closest industrial city, e.g., Lille in the North of France or Marseille in the South. However, Paris attracted migrants from all over the country. Overall, the descriptive statistics Table A1 indicate that 17.3% of the French population emigrated from their department of origin over the 1861-1911 period.

It must be noted that our study does not account for international migration for two reasons. First, as we mentioned above, the French did not migrate to high land to labor ratio (and therefore high-fertility) destinations such as the USA and other European offshoots, unlike the inhabitants of other European countries (e.g., Great Britain, Ireland, Sweden or Norway). The annual mean French gross emigration rate from 1860 to 1913 was only 0.18 international emigrants per 1000 inhabitants (including to French colonies and in particular to Algeria), compared to 9.25 for Italy, 4.61 for Great-Britain and 1.5 for Germany (Hatton and Williamson, 1998). Instead, most French migration during the 19th century took place within France.[14] Second, there was some foreign immigration to France, but it was limited, only amounting to 2.9% of the total population in 1911 (Dupâquier and Poussou, 1988). In any case, international migration did not prevent the decline and convergence of fertility rates in France.

Rather, the importance of internal migrations in France and of external migrations in other European countries may explain the specific effect of migration on fertility in France for at least two reasons. First, the implied patterns in terms of self-selection on fertility behavior are different. Second, the potential transmission of fertility norms from destination-to-origin regions would work in opposite directions, because the urban and industrial destinations of French internal migrants were predominantly low-fertility places, in contrast to the countries in the New World where high land-to-labour ratios favored large families in rural areas. Indeed, as Livi-Bacci 2012, pp 54-55) writes: "International rural-to-rural migration required stable families with large numbers of children. Families of that sort were well suited to the destination countries where land was abundant and so a large family of workers an advantage. Similarly

[13] A similar pattern was documented by, e.g., Cairncross (1949) and Baines and Woods (2004), for Great Britain.

[14] Given the low numbers of French emigrants abroad, it does not seem relevant to investigate which emigrants moved within the country and which emigrants left the country, as might be the case for emigration studies for countries like Sweden or Great Britain.

advantageous were the traditional social and family values of those migrants. Migration from the countryside to cities and industrial regions, where workers were employed primarily as wage workers in manufacturing and construction, favored instead a different profile, namely, individuals whose family ties were looser, nuclear families able to carefully plan births."

2.3 Economic and social characteristics of the departments

In our empirical analysis, we control for the socio-economic factors which might have contributed to the convergence in fertility rates in France in the second half of the 19th century.

2.3.1 Life expectancy and child mortality

We use Bonneuil (1997)'s computations of life expectancy at age 15 for the individuals living in each department during the 1806-1906 period which we extend to 1911 by using data from the French census. We also rely on the successive issues of the French census to compute infant mortality, which we define as the share of children who died before age one.

2.3.2 Education and religiosity

The regressions account for the confounding effects of education on fertility. For this purpose, we compute the shares of the male and female population age five to 19 enrolled in primary and secondary schools.[15]

Moreover, education may be correlated with religiosity. Therefore, to assess the confounding effects of religious observance on fertility we collect data from the French census to compute the share of male and female children enrolled in Catholic (i.e., private) primary and secondary schools, as opposed to those studying in secular state-funded primary and secondary schools.[16]

2.3.3 Workforce and urbanization

[15] In 1881 and 1882, laws were passed to make primary school attendance until the age of 13 mandatory and to make state-funded schools tuition-free and secular. Therefore, to get a better sense of educational achievement in France during the period, we also consider secondary school attendance until age 19.

[16] Since data on actual church attendance is unavailable for the 1861-1911 period, we use a measure of school choice, which is very often motivated by religious observance (e.g., Cohen-Zada, 2006). However, it is not a priori clear whether the decline in religiosity was connected to the decline in fertility in France. Departments such as *Côtes du Nord* and *Nord* experienced a decline in fertility during the 19th century but remained staunchly Catholic until WWI and notably elected representatives who opposed the separation of Church and State in 1905 (Franck, 2010).

Our regressions account for the confounding effects of changes in the workforce in the 19th century, characterized by the decline in the agricultural sector and the growth of the industry, as well as of urbanization, on fertility. For this purpose, we compute the shares of the workforce in the industrial and service sectors (the control group is the workforce in the agricultural sector) as well as the share of the population living in urban areas (the control group is the population in the rural areas).

3. Empirical methodology

3.1. *Baseline model*

To assess the impact of migration on fertility, we estimate the following equation:

$$\log(f_{i,t}) = a_1.\log(ERFN_{i,t}) + a_2.log(em_{i,t}) + a_3.log(em_{i,t}).\log(ERFN_{i,t}) + a_4.\log(IBFN_{i,t}) + a_5.log(im_{i,t}) + a_6.log(im_{i,t}).\log(IBFN_{i,t}) + b.\log(X_{i,t}) + \alpha_i + \alpha_t + \varepsilon_{i,t} \quad (2)$$

where $f_{i,t}$ is the fertility rate in department *i* in year *t*, $X_{i,t}$ is a vector of socio-economic variables in department *i* in year *t*, α_i and α_t are department- and year-fixed effects while the fertility norms of immigrants and emigrants are defined in line with Spilimbergo (2009) as weighted averages of the fertility rates in the migrants' origin/destination department such that

$$ERFN_{i,t} = \left(\sum_{j\neq i} M_{ij,t}.f_{j,t}\right) / \left(\sum_{j\neq i} M_{ij,t}\right) \quad (3)$$

where ERFN is the emigrants' residence fertility norm and $M_{ij,t}$ is the number of people born in department *i* living in department *j* at time *t*, $f_{j,t}$ is the fertility rate of *department j* at time *t*, and

$$IBFN_{i,t} = \left(\sum_{j\neq i} M_{ji,t}.f_{j,t}\right) / \left(\sum_{j\neq i} M_{ji,t}\right) \quad (4)$$

where IBRN is the immigrants' birthplace fertility norm.

In addition, we define the share of emigrants, $em_{i,t}$, in proportion of the population of department *i*

$$em_{i,t} = \left(\sum_{j\neq i} M_{ij,t}\right) / P_{i,t} \quad (5)$$

and the share of immigrants, $im_{i,t}$, among inhabitants of department *i* as

$$im_{i,t} = \left(\sum_{j\neq i} M_{ji,t}\right) / P_{i,t} \quad (6)$$

where $M_{ij,t}$ is the number of people born in department *i* living in department *j* at time *t* and $P_{i,t}$ is the total population of department *i* at time *t*.

To estimate Equation (2), we follow the methodological approach of Brown and Guinnane (2007) and Guinnane (2011) in their analysis of the European fertility decline (Coale and Watkins, 1986). We include interaction terms between the fertility norms and the shares of emigrants/immigrants to check whether the intensity of the diffusion is larger where there are more migrants. We also include department and time fixed effects to exploit within-department variations across periods and correct for unobserved heterogeneity between departments. However, it is a priori unclear whether we should specify Equation (2) in growth rates or in levels, and whether we should include a lagged dependent variable and/or lagged explanatory variables to account for the potential delayed effects of economic changes. Our additional regressions, which are available upon request, suggest that it is preferable to use a specification in level without lagged variables.

3.2. *Identification strategy*

To estimate Equation (2), we use changes in travel costs via the railroad network within France as an instrumental variable. This identification strategy is motivated by the fact that travel costs were time-varying during the 19th century, as the railroad network was gradually built throughout the country. A decrease in travel costs should therefore lower the costs of migration and increase the stock of migrants. Indeed, transport costs were substantial enough to matter. Even in 1901, the cheapest train ticket (in third class) between Paris and Lyon (approximately 450 km) cost three days of a Parisian worker's wages and five days of a provincial one. A coach ticket was three times as expensive. In 1872, these numbers would have been six and 10.5 days (France - Statistique des salaires, 1901). [17]

Our first stage regression estimates a panel gravity model with the standard Poisson Pseudo Maximum Likelihood that solves for heteroskedasticity and for the existence of zero migrant stocks (Silva and Tenreyro, 2006):

$$\log(M_{ij,t}) = a + b.\log(transport\ costs_{t-20}) + c.\log(transport\ costs_{t-30}) + \beta_t + \beta_o + \beta_d + \varepsilon \qquad (7)$$

[17] For the sake of comparison, the cheapest ticket was worth five hours of the net minimum wage in 2012.

where $M_{ij,t}$ are the migrant stocks while β_t, β_o and β_d are the year-, origin-department and destination-department fixed effects. We use 20 and 30-year lagged transport costs because the mean migrant age was, according to the TRA dataset, 38 years old in 1861, 40 in 1872, 41 in 1881, 43 in 1891, 45 in 1901 and 50 in 1911, i.e. between 20 and 30 years after migration. These transport costs are computed in a four-step procedure. First, we use Caron (1997)'s rail network map to determine the available travel (railroad, road, sea) links between adjacent departments. Second, we compute the great-circle distance between the administrative centres (*chef-lieu*) of adjacent departments. Third, since rail prices were regulated by the State (Toutain, 1967, p. 277), there was a constant road or rail price per kilometer throughout France and this strategy provides the travel cost between adjacent *departments*. Fourth, we apply a short-route finding algorithm taken from the UCINET network analysis program (Borgatti et al., 2006) to compute the cheapest route and hence the travel costs between each *department*.

To be a valid instrument, transport costs must not only correctly predict bilateral migration but they should also neither entail reverse causality nor violate the exclusion restriction by affecting the cultural diffusion of fertility norms through other channels than migration. This will lead us to provide a series of robustness checks in Section 4.2. At this point, however, it is worth noting that reverse causality may only be an issue if migrants are self-selected on preferences for fertility and choose their destination accordingly.[18] Individuals living in a low- (respectively, high-) fertility department who have preferences for large (small) families may have found it beneficial to migrate to a high- (low-) fertility department where their own preferences are more in line with the prevailing norms in terms of family size. However, this would have not contributed to a convergence but to a divergence in the fertility rate across departments. As such, reverse causality and the self-selection of emigrants would imply that our OLS coefficients underestimate the actual effect of migration on the fertility decline.

As for the exclusion restriction, the historical account on the development of the French railroad network suggests that it took place independently of fertility patterns, or of the demand and supply for migration (Caron, 1997). Indeed, from the 1840s

[18] Home fertility is well recognized as a push factor of international migration but fertility at destination is not thought to be a significant pull factor (Mayda, 2010).

onwards, the French government designed the railroad network to connect Paris to the main economic centres of the country and by the mid-1880s, the railroad network connected all the main administrative towns (*chef-lieu*) of each *department*.[19] To illustrate our point, we graph in the Supplementary Appendix the Coale fertility index of each department between 1811 and 1911 and a vertical line that indicates when the department was linked to Paris via the railroad. These graphs show that the introduction of the railroad was not linked to the decline in fertility.

Table 1 reports the regression results of the first-stage regression in Equation (7) where we assess the relationship between our IV transport costs and migrant stocks. Column 1 considers all migrants while Columns 2 and 3 distinguish between male and female migrants.[20]

The first-stage regression results show that migrant stocks decline with increasing travel costs, as could be expected. In other words, migrations increased as travel costs decreased. In particular, our results in Column 1 suggest that the elasticity between 20-year lagged transport costs and migrant stocks is -0.9 while that between 30-year lagged transport costs and migrant stocks is -0.6. Given that the median decrease in bilateral transports costs until 1891 is equal to 13%, these figures suggest that the median increase in bilateral migrant stocks every decade after 1861 predicted by transport costs is 19.5%. Given that the actual figure is 20%, this finding corroborates the validity of our first-stage results. An intuition for these results is that the decline in bilateral transport costs at time t predicts more or less accurately the increase in bilateral migrant costs at time t+30 years. Finally, we note that the first stage regression results reported in Columns 2 and 3 suggest that there is no specific effect for men or women, either in terms of size or magnitude.

A potential concern with our identification strategy is that transport costs and migration may be correlated with other factors which also influence fertility rates. We discuss this issue in Section 4.2 and provide several robustness checks for the size, significance and validity of our results.

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[19] This design, which originally comprised seven lines, was named *L'Etoile de Legrand* (Legrand's star), after the then under-secretary of public works. In the Supplementary Appendix, we show the state of development of the railroad network in 1856.

[20] The results in Columns 2 and 3 of Table 1 should be seen as robustness checks since our instrumental variable, transport costs, does not vary by gender.

4. Results

4.1. *The effect of migration on the decline in fertility*

Table 2 analyses the impact of migration of men and women on the convergence in the fertility rates of the French departments. Columns 1 and 2 report OLS estimates while Column 3 show IV estimates. Column 1 only includes the fertility norms of emigrants and immigrants, the shares of migrants and the interaction variables while Columns 2 and 3 also includes our set of control variables. It appears that none of these controls has a significant effect on fertility, except for infant mortality.

The results in Table 2 suggest that immigrants and emigrants did not have the same effect on the fertility convergence between 1861 and 1911. At first glance, immigrants seem to have no systematic effect on fertility while emigrants do. Indeed, the positive and significant coefficient of *Emigrants' Residence Norm* suggests that departments whose emigrants moved to destinations with strongly declining fertility experienced a larger decline in their own fertility. Moreover, the negative and significant coefficient of *Share of Emigrants* suggests that departments with the largest increase in the share of emigrants experienced the largest drop in fertility.

However, we cannot interpret the coefficients of the interacted variables by themselves. We note that the interaction variable *Emigrants' Residence Norm * Share of Emigrants* has a negative and significant sign.[21] This suggests two possible interpretations. On the one hand, the interaction variable mitigates the effect of the two variables *Emigrants' Residence Norm* and *Share of Emigrants* taken separately because individuals who remained in departments with an increasing share of emigrants moving to low-fertility areas were more likely to have a high number of children. On the other hand, the interaction variable suggests that the effect of the Emigrants' Residence Norm is lower at high levels of emigration. This is suggestive of diminishing returns to migration in terms of informational transmission, in line with the rest of the literature (e.g., Spilimbergo (2009) and Beine et al. (2013)). In any event, our counterfactual analysis in Section 5.2 provides a quantitative discussion of how these different effects balance out. However, we first provide a series of robustness checks in the next subsection.

[21] In the studies of Spilimbergo (2009) and Beine et al. (2013) whose specification is very similar to ours, this interaction term is not significant.

4.2. *Robustness checks*

Some concerns pertaining to our analysis may be related to the endogenous relationship between migration and fertility. While reverse causality and the self-selection of migrants are unlikely to bias our estimates as we discussed in Section 3.2, our identification strategy is meant to address potential omitted variable bias and ensure the validity of the exclusion restriction in our regressions. Specifically, it could be argued that lower transport costs could ease the diffusion of norms of low fertility, not just through migration, but also through other channels, notably the diffusion of newspapers and books.[22] More generally, one may also be concerned that transport costs in the second half of the 19th century are associated with other forces that could have shaped the joint evolution of migration and fertility. However, it is worth noting that in 19th century France, there were internal tariffs, known as *octrois*, which constituted an impediment to the circulation of many goods (Franck et al., 2014).

To mitigate these concerns, we run three series of robustness checks. First, we test whether there is a relationship between migrant stocks between 1861 and 1911, whether instrumented by the fall in transport costs or not, and the fertility decline between 1811 and 1861. It is reassuring to find in Table 3 that there is not such a relationship.

Second, we include a series of "bad controls" (Angrist and Pischke, 2009) which are potentially endogenous to migration and fertility in the regressions in Table 2. These include other potential vectors of cultural diffusion, such as the total number of periodicals published in each year and each department. These also include demographic variables that could be correlated with both migration and fertility[23], such as the share of births out of wedlock, the share of illegitimate births as a share of out-of-wedlock births, as well as the shares of married men and women for the 20-24, 25-29, 30-34 and 35-39 age groups. Except for the total number of periodicals which we collect from the successive issues of the *Bibliographie de la France ou Journal général de l'imprimerie* as well as from Avenel (1895, 1901) and Mermet (1880-

[22] Newspapers and books are high value-to-weight whose dissemination across France between 1851 and 1911 was more likely to be influenced by changes in the availability of transport rather than by changes in transportation costs. On the diffusion of newspapers and, in particular, on the importance of regional newspapers outside Paris, see, e.g., Manevy (1955), Bellanger (1969) and Albert (1972).

[23] Since these variables are likely endogenous, they are not included in our baseline regressions.

1901), all these other variables are collected from the successive issues of the French census. The results are reported in Table 4. We find that none of these "bad controls" has a consistent effect on the coefficients of our variables of interest, either in terms of size or significance level.

Third, there might be some concern that our results are driven by spatial autocorrelation, given the nature of our data and empirical strategy (see also Murphy (2015)). It is therefore reassuring to find in Table 5 that our main regression results are robust to accounting for the inclusion of spatial autocorrelation.

5. Channels of the fertility decline: a counterfactual analysis

In this section, we discuss possible channels through which emigration affected fertility. Specifically we carry out a counterfactual analysis to examine potential differences between the migration of men and of women, as well as the role of migration from and to Paris.

Tables 6 and 7 present regression results on a sample that only includes male and female migrants, respectively. Moreover, the sample in the regressions shown in Table 8 excludes all migrants (i.e., men and women) to and from Paris, which made up most of the *Seine* department.

In Tables 6 and 7, the significance and the size of the coefficients associated with *Emigrants' Residence Norm*, *Share of Emigrants* and *Emigrants' Residence Norm * Share of Emigrants* are roughly similar to those in Table 2. These results suggest that male and female emigrants contributed equally to the fertility decline. They are thus in line with the historical evidence that long-term migrations, which our study analyses to capture the decline in fertility, were often joint migrations of men and women, unlike short-term migrations which were overwhelmingly undertaken by men alone (Châtelain, 1976).[24]

[24] We note that in Table 7 the *Share of (Female) Immigrants* and the interaction variable *(Female) Immigrants' Residence Norm * Share of (Female) Immigrants* have positive and significant coefficients. This effect is however not found for male immigrants. While these results confirm our remark in Section 4.1 that immigrants had overall no effect on the decline in fertility, it nonetheless suggests that female immigrants did not immediately adopt the lower norms of their department of destination. It is likely that they had more children than the women in their destination department but fewer children than in their origin department. As such their behaviour did not prevent the convergence in fertility rates.

In Table 8, we report regression results on a sample that excludes male and female migration from and to the *Seine* department (which comprised Paris). They are different from those in Table 2 since the coefficients associated with *Emigrants' Residence Norm*, *Share of Emigrants* and *Emigrants' Residence Norm * Share of Emigrants* are smaller in Table 8 and not systematically statistically significant across the OLS and IV regressions. They actually suggest that migration to Paris played a major role in the decline in fertility in France, even though our data indicate that only 26.33% of migrants lived in Paris throughout the period.[25] We develop this intuition in our counterfactual analysis below.

We then compute the counterfactual values of the fertility rate in each department under the assumption that the size, bilateral structure, and fertility of emigrants and immigrants would have remained at their 1861 level. For this purpose, we use the OLS and IV regression results in Columns 2 and 4 (with the control variables) of Tables 2, 6, 7 and 8 (i.e., on the samples of all migrants, only male migrants, only female migrants, as well as of all migrants excluding *Seine* as destination and origin). In Table 9, we report these counterfactual values at the national level along with the actual fertility data between 1861 and 1911. We assess the fit of each model with the Pearson χ^2 statistic as in Buchinsky et al. (2014).[26] Overall, the Pearson χ^2 statistic shows that our regressions capture the impact of migration on fertility decline.

To illustrate our analysis, we report two graphs based on the counterfactual values obtained with the IV regressions reported in Column 4 of Tables 2, 6, 7 and 8 and reported in Table 9. First, Figure 3 shows the evolution of the actual and counterfactual values for the IV regressions of the unweighted average fertility rate at the national level between 1861 and 1911 under the assumption that no changes in fertility norms and in the shares of migrants had occurred after 1861. Second, Figure 4 shows the distribution of these values across departments in the form of histograms, thus highlighting the decline in the standard error of fertility rates over time and the progressive convergence of fertility rates across French regions.

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[25] Only 5.25% of the total emigrants were born in the *Seine* department throughout the period.

[26] The Pearson χ^2 statistic is computed as $\chi^2 = \sum_{i=1}^{81} (Predicted_i - Observed_i)^2 / Predicted_i$. The critical values at the 10%, 5% and 1% levels of significance are $\chi^2_{.90}(80)$=64.218, $\chi^2_{.95}(80)$ =60.391 and $\chi^2_{.99}(80)$=53.540.

Three general observations can be drawn from Table 9 as well as from Figures 3 and 4. First, the counterfactual values of the average Coale fertility index are larger than the actual values. For instance, Table 9 (see Panel A of Figures 3 and 4) indicates that the average French Coale fertility index would had been 0.293 in 1911 had there been no change in migration of men and women after 1861, instead of 0.244. Since the national Coale fertility index in 1861 was equal to 0.310, these findings imply that the 0.66 point drop in fertility in France between 1861 and 1911 can be broken down into a 0.49 point drop caused by migration and a 0.17 point drop which can be attributed to other economic and demographic factors, most likely to infant mortality since it is the only other significant variable in our regressions. It is also interesting to note that the counterfactual values for the standard deviation of the Coale Fertility Index are larger than the predicted values, but still lower than the actual values. In other words, while our model slightly under-estimates the standard deviation of fertility, it nonetheless suggests that migration contributed to the convergence of fertility rates across France. Moreover, the figures in Table 9 (see Panels C and D of Figures 3 and 4) suggest that the fertility decline can be equally attributed to male and female migration.

Second, the counterfactual values indicate that the average French Coale Fertility Index would have been equal to 0.265 (see Panel E of Figures 3 and 4) under the assumption that no change in fertility norms in origin departments and in the share of immigrants had occurred after 1861 and equal to 0.266 under the assumption that no change in fertility norms in destination departments and in the share of emigrants had occurred after 1861 (see Panel F of Figures 3 and 4). These findings suggest that the depressing effects on fertility of the changes in *Emigrants' Residence Norm* and *Share of Emigrants* and of the changes in *Immigrants' Birthplace Norm* and *Share of Immigrants* are equally large, at least at the national level.

Third, Table 9 suggests that Paris played a major role in the decline in fertility rates throughout the period.[27] As can be seen in Panel B of Figures 3 and 4, the

[27] The *Seine* department, which includes Paris, along with *Seine-et-Oise* and *Seine-et-Marne*, which comprise the Parisian suburbs, were areas of low fertility by the mid-19th century. In 1901 and 1911, the fertility of *Seine* was below the 5th percentile of fertility in France. In addition, the total French population amounted to 37,386,313 inhabitants in 1861 and to 41,479,006 in 1911, while there were 1,953,660 inhabitants in Seine in 1861 and 4,154,042 in 1911. Hence, *Seine* accounted for 5.2% of the French population in 1861 and 10% in 1911

counterfactual average value of the Coale fertility index in the IV regression in the absence of migration to and from *Seine* is found to be much higher than its actual level in 1911 (0.276 vs. 0.244). Given that the national Coale fertility index in 1861 was equal to 0.310, these findings imply that the counterfactual fertility decline without Paris is only one half of the actual drop (0.34 points instead of 0.66). In other words, since 26.33% of the total migrants moved to the *Seine* department between 1861 and 1911, our counterfactual analysis suggests that the information sent back to their department of origin by one immigrant to *Seine* had the same depressing effect on fertility as three immigrants who moved to other departments.[28]

All in all, these observations thus suggest that emigrants to the *Seine* department mattered more than other emigrants, and this is in line with the cultural, economic and political importance of Paris within France. We may think that would-be emigrants sought to move to Paris, even if they eventually migrated to the closest regional industrial center, and chose to have few children because they learnt from emigrants from their regions that individuals who were already living in Paris had few children. This might have been a cultural element of Parisian life, and there is evidence that the political and economic elites living in Paris already had few children by the end of the 18th century (Livi-Bacci 1986). But this feature of Parisian life might also have been grounded in an economic rationale: Parisians had few children because raising many children in Paris was costly and difficult. In fact, it was customary for Parisians to send new-borns to foster care in the countryside, even though this was expensive and infant mortality rates were high (Rollet-Echalier, 1990).[29] As such, our analysis of the results suggests an explanation for the lower fertility rates in France before WWI which pertains to the diffusion via migrants of an information which combined a cultural component and an economic rationale related to the cost of child rearing in Paris.

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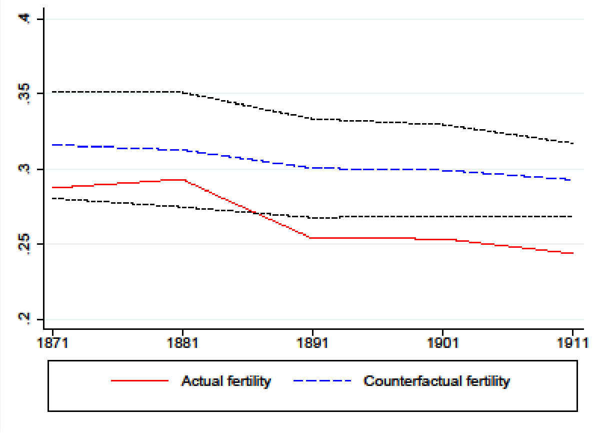
[28] Throughout the period, only 5.25% of the total emigrants were born in the *Seine* department and lived elsewhere. They are found not to have played a major role in the decline in fertility.

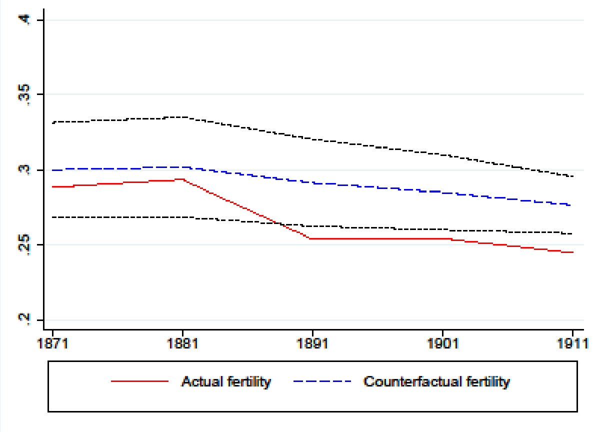
[29] The poorer the French couples were, the further away they would have to send their children from Paris. In the second half of the 19th century, well-to-do families would employ a wet nurse at home to take care of their children (Faÿ-Sallois, 1980). See also Rapoport and Vidal (2007) for additional anecdotal evidence and an interpretation in terms of endogenous parental altruism formation.

Figure 3. Counterfactual fertility in France, 1861-1911

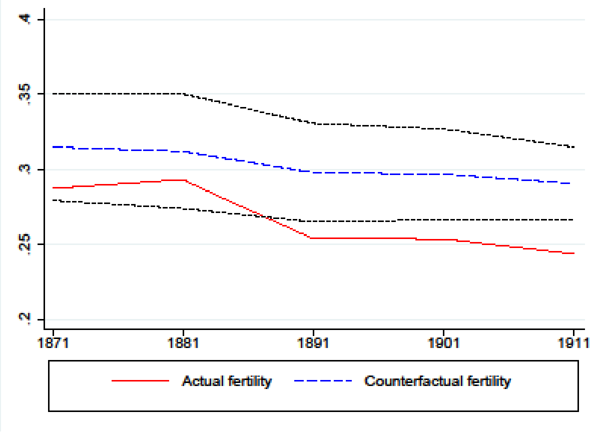
Panel 3a. Counterfactual fertility in France under no change in migration after 1861



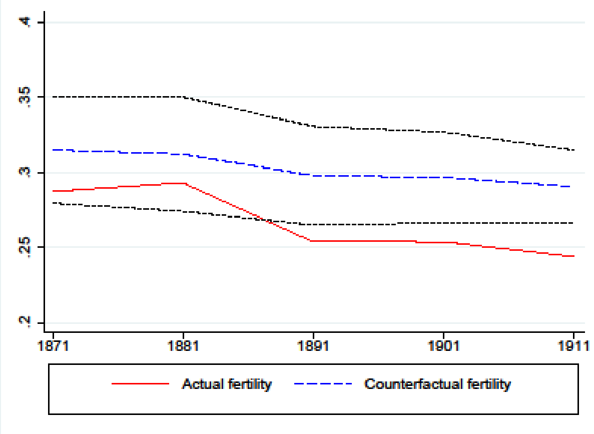
Panel 3b. Counterfactual fertility in France under no changes in migration from and to Paris after 1861



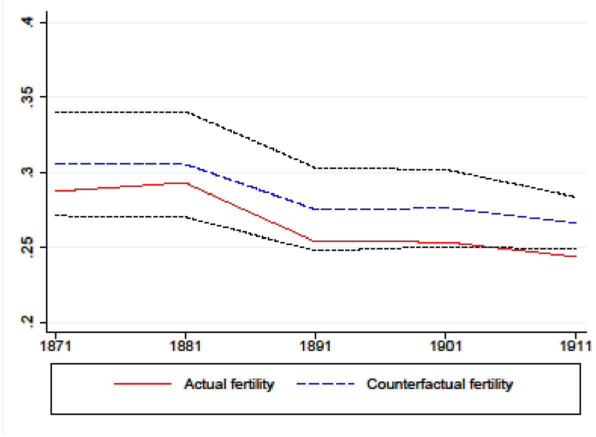
Panel 3c. Counterfactual fertility in France under no changes in female migration after 1861



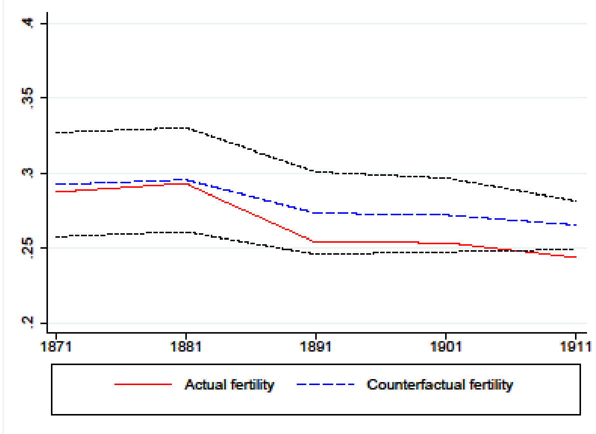
Panel 3d. Counterfactual fertility in France under no changes in male migration after 1861



Panel 3e. Counterfactual fertility in France under no change in immigration after 1861



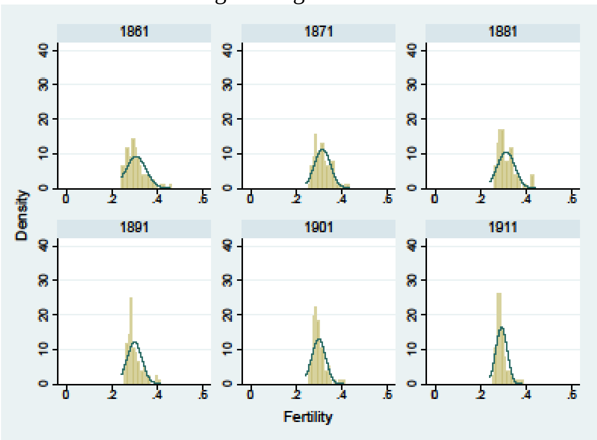
Panel 3f. Counterfactual fertility in France under no change in emigration after 1861



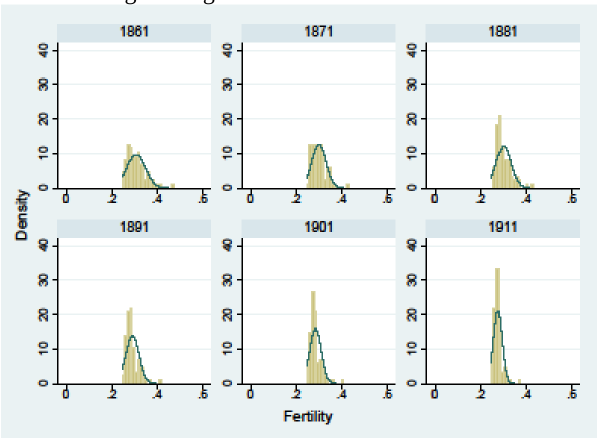
Note: This figure graphs the evolution of the actual, IV-predicted and counterfactual IV-predicted of the fertility rate for the whole of France using the IV regression results with the control variables in Column 4 of Tables 2, 5, 6 and 7 and as reported in Table 9. The dotted black lines in each panel indicate the bounds of the 95%-confidence interval for the predicted values of counterfactual fertility.

Figure 4. Counterfactual histogram of fertility in France, 1861-1911

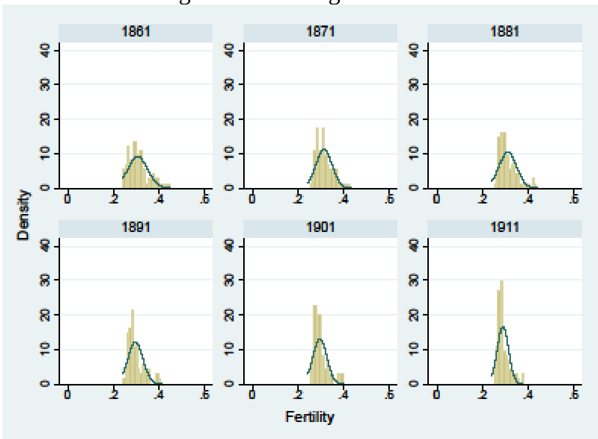
Panel 4a. Counterfactual histogram of French fertility under no change in migration after 1861



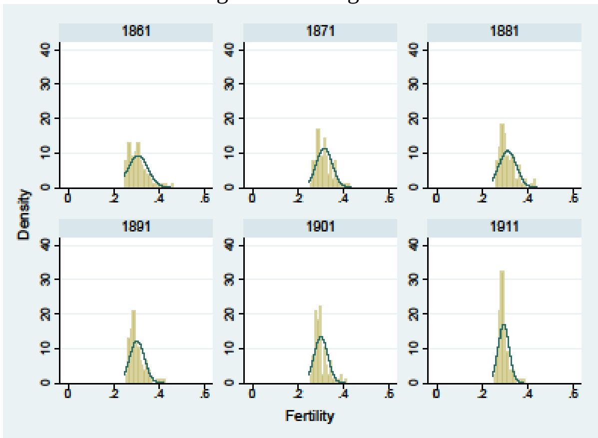
Panel 4b. Counterfactual histogram of French fertility under no change in migration from and to Paris after 1861



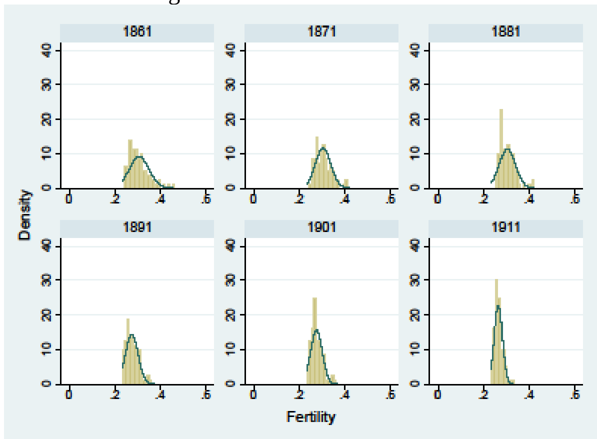
Panel 4c. Counterfactual histogram of French fertility under no change in female migration after 1861



Panel 4d. Counterfactual histogram of French fertility under no change in male migration after 1861



Panel 4e. Counterfactual fertility in France under no change in immigration after 1861



Panel 4f. Counterfactual fertility in France under no change in emigration after 1861

Note: This figure provides histograms for the counterfactual values of the fertility rate in the French departments using the IV regression results with the control variables in Column 4 of Tables 2, 5, 6 and 7 and as reported in Table 9.

6. Conclusion

In this study, we investigate the impact of migration on the fertility transition. We focus on the convergence in fertility rates within France between 1861 and 1911 by taking advantage of the fact that internal migration was much more prevalent than international migration over that period (in contrast to most other European countries). Using various historical data sources, we build a bilateral migration matrix between French departments, with observations every ten years. We then assess the effects of the changing fertility norms of emigrants and immigrants in their birthplace and residence departments. We address the endogeneity of migration choices by using time-varying bilateral travel costs resulting from the gradual development of the railroad network as an instrumental variable.

Our results suggest that the transmission of information via migration explained most the convergence of fertility rates across France while socio-economic variables had, at best, a limited impact. In particular, emigrants sent back information to their region of origin regarding the decreasing fertility norms of their region of destination. It is therefore plausible that emigrants sent information to those who stayed behind, but who might have wanted to emigrate in the future. This information regarding social norms about family size could also have been grounded in an economic rationale pertaining to the cost of raising children in urban areas, and specifically in Paris. Our interpretation is consistent with the idea that the lack of external migration might have been crucial in explaining French exceptionalism in Europe. Internal migration was, relative to all migrations, an order of magnitude more important in France than in other European countries. The effect of French cultural unification, especially the emulation of Paris as the focus point of cultural change, was thus not counterbalanced by the potential influence of high-fertility New World destinations on fertility levels, as may have occurred in other European countries. As such, our results are in line with the notion that France progressively became a fully culturally integrated country in the course of the 19^{th} century.

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Table 1: Travel costs and migration: first stage regressions

The dependent variable is $m_{ij,t}$ the (log of the) stock of migrants born in *départment i* living in *départment j* at time *t*

	All migrants	Male migrants	Female migrants
20-year lagged log(travel costs)	-0.9***	-0.8***	-0.9***
	(0.06)	(0.08)	(0.07)
30-year lagged log(travel costs)	-0.6***	-0.7***	-0.5***
	(0.05)	(0.06)	(0.06)
Year fixed effects	Yes	Yes	Yes
Origin-*département* & destination-*département* fixed effects	Yes	Yes	Yes
Pseudo R2	0.60	0.53	0.55
Number of clusters	7310	7310	7310
Number of observations	43,690	43,690	43,690

Note: Robust standard errors clustered at the origin-department. & destination-department are reported in brackets. *** indicates significance at the 1%-level, ** indicates significance at the 5%-level, * indicates significance at the 10%-level.

Table 2: Determinants of the fertility decline in France, 1861-1911: all migrants

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t)			
Emigrants' Residence Norm (t)	0.539***	0.397***	0.364	0.788**
	[0.136]	[0.107]	[0.320]	[0.302]
Immigrants' Birthplace Norm (t)	0.0631	-0.149	1.289***	0.378
	[0.126]	[0.0937]	[0.263]	[0.287]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-1.655***	-1.300**	-3.046***	-2.990***
	[0.620]	[0.530]	[0.889]	[0.788]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	2.288**	3.113***	0.0166	1.104
	[0.981]	[0.721]	[1.320]	[0.806]
Share of Emigrants (t)	-2.800***	-2.025**	-4.214***	-3.973***
	[1.045]	[0.819]	[1.375]	[1.200]
Share of Immigrants (t)	4.273***	4.911***	1.155	1.818*
	[1.305]	[0.981]	[1.810]	[1.000]
Life Expectancy Age 15 (t)		-0.00871		-0.00855
		[0.00912]		[0.0106]
Infant Mortality (t)		0.684**		0.649*
		[0.299]		[0.346]
Urban (t)		-0.0926		0.152
		[0.320]		[0.298]
Industries (t)		-0.0122		-0.00283
		[0.00745]		[0.00697]
Professionals (t)		-0.0137		-0.00641
		[0.0134]		[0.0126]
Female Education (t)		-0.0472		-0.0209
		[0.0414]		[0.0401]
Male Education (t)		0.00908		0.00840
		[0.0484]		[0.0500]
Share of Girls in Primary Catholic Schools (t)		0.0111		0.0172
		[0.0181]		[0.0213]
Share of Boys in Primary Catholic Schools (t)		-0.000696		0.00441
		[0.0156]		[0.0154]
Constant	-0.512**	-0.830	0.707**	0.320
	[0.198]	[0.513]	[0.294]	[0.632]
Within R2	0.6	0.75	0.7	0.76
F-stat	41.9	50.03	39.7	59.60
Prob > F-stat	0.0	0.00	0.0	0.00
Year-fixed effects	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81
Observations	486	486	486	486

Note: This table reports the full results of Table 2. All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 3. Migration in 1861-1911 and lagged fertility in 1811-1861

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t-50)			
Emigrants' Residence Norm (t)	0.00611	-0.164	-0.381	-0.335
	[0.147]	[0.142]	[0.313]	[0.304]
Immigrants' Birthplace Norm (t)	-0.0680	-0.101	0.343	-0.134
	[0.146]	[0.142]	[0.326]	[0.352]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	0.416	0.827	-0.475	-0.0261
	[0.930]	[0.865]	[1.124]	[1.129]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	0.0496	0.0918	0.231	0.885
	[1.100]	[1.111]	[1.014]	[1.009]
Share of Emigrants (t)	1.028	1.696	-0.550	-0.0403
	[1.514]	[1.373]	[1.585]	[1.590]
Share of Immigrants (t)	0.292	0.00920	-0.406	0.159
	[1.409]	[1.379]	[1.395]	[1.356]
Life Expectancy Age 15 (t)		0.0234		0.0284**
		[0.0142]		[0.0142]
Infant Mortality (t)		0.864*		1.070**
		[0.449]		[0.442]
Urban (t)		-0.116		-0.237
		[0.212]		[0.172]
Industries (t)		0.0103		0.00459
		[0.00940]		[0.0100]
Professionals (t)		-0.00922		-0.0111
		[0.0171]		[0.0179]
Female Education (t)		-0.0960		-0.122**
		[0.0673]		[0.0576]
Male Education (t)		-0.00695		-0.0101
		[0.0620]		[0.0556]
Share of Girls in Primary Catholic Schools (t)		-0.0405		-0.0343
		[0.0281]		[0.0305]
Share of Boys in Primary Catholic Schools (t)		0.0343*		0.0232
		[0.0194]		[0.0199]
Constant	-1.089***	-2.686***	-0.943***	-3.106***
	[0.249]	[0.808]	[0.274]	[0.828]
Within R2	0.5	0.57	0.6	0.59
F-stat	21.6	23.52	27.1	21.84
Prob > F-stat	0.0	0.00	0.0	0.00
Year-fixed effects	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81
Observations	486	486	486	486

Note: This table reports the full results of Table 3. All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 4. Migration and the fertility decline, 1861-1911, accounting for newspapers, out-of-wedlock births, age at marriage

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	IV	IV	IV
	Dependent variable is Fertility(t)					
Emigrants' Residence Norm (t)	0.388***	0.386***	0.395***	0.783**	0.775**	0.796**
	[0.108]	[0.112]	[0.102]	[0.301]	[0.299]	[0.304]
Immigrants' Birthplace Norm (t)	-0.138	-0.148	-0.153	0.391	0.384	0.334
	[0.0940]	[0.0956]	[0.0992]	[0.286]	[0.284]	[0.298]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-1.277**	-1.266**	-1.311**	-2.981***	-2.945***	-3.054***
	[0.543]	[0.542]	[0.516]	[0.788]	[0.792]	[0.771]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	2.967***	3.115***	3.185***	0.930	1.076	1.180
	[0.718]	[0.720]	[0.812]	[0.760]	[0.821]	[0.773]
Share of Emigrants (t)	-1.993**	-1.978**	-2.014**	-3.978***	-3.905***	-4.064***
	[0.835]	[0.846]	[0.795]	[1.199]	[1.204]	[1.178]
Share of Immigrants (t)	4.725***	4.916***	5.041***	1.612*	1.786*	1.929**
	[0.977]	[0.979]	[1.109]	[0.921]	[1.016]	[0.942]
Life Expectancy Age 15 (t)	-0.00858	-0.00861	-0.00994	-0.00857	-0.00859	-0.0101
	[0.00923]	[0.00911]	[0.00953]	[0.0106]	[0.0106]	[0.0105]
Infant Mortality (t)	0.687**	0.688**	0.621**	0.645*	0.647*	0.581*
	[0.300]	[0.298]	[0.310]	[0.344]	[0.346]	[0.345]
Urban (t)	-0.0661	-0.0956	-0.0739	0.183	0.144	0.177
	[0.319]	[0.320]	[0.323]	[0.292]	[0.300]	[0.292]
Industries (t)	-0.0120	-0.0118	-0.0114	-0.00238	-0.00223	-0.00288
	[0.00742]	[0.00751]	[0.00766]	[0.00696]	[0.00701]	[0.00726]
Professionals (t)	-0.0123	-0.0144	-0.0119	-0.00463	-0.00774	-0.00427
	[0.0134]	[0.0137]	[0.0131]	[0.0127]	[0.0127]	[0.0122]
Female Education (t)	-0.0474	-0.0470	-0.0530	-0.0205	-0.0196	-0.0294
	[0.0410]	[0.0415]	[0.0409]	[0.0391]	[0.0402]	[0.0394]
Male Education (t)	0.00747	0.00780	0.00767	0.00661	0.00766	0.00696
	[0.0477]	[0.0485]	[0.0480]	[0.0487]	[0.0502]	[0.0488]
Share of Girls in Primary Catholic Schools (t)	0.0125	0.0106	0.0120	0.0190	0.0165	0.0184
	[0.0182]	[0.0183]	[0.0178]	[0.0220]	[0.0216]	[0.0209]
Share of Boys in Primary Catholic Schools (t)	-0.00187	-0.000552	-0.00161	0.00300	0.00475	0.00389
	[0.0156]	[0.0158]	[0.0156]	[0.0156]	[0.0154]	[0.0159]
Total Number of Periodicals (t)	-0.0188			-0.0236		
	[0.0163]			[0.0147]		
Share of Children Born out of Wedlock		-0.0599			-0.0951*	
out of the Total Number of Births (t)		[0.0593]			[0.0502]	
Share of Not Legitimized Children		-0.00257			-0.0206	
out of Those who were Born out of Wedlock (t)		[0.0473]			[0.0400]	
Share of Married Men Age 20-24			0.101			-0.0155
			[0.163]			[0.155]
Share of Married Women Age 20-24			0.102			0.125
			[0.144]			[0.131]
Share of Married Men Age 25-29			-0.118			-0.131
			[0.129]			[0.135]
Share of Married Women Age 25-29			0.0546			0.0828
			[0.187]			[0.174]
Share of Married Men Age 30-34			-0.253*			-0.276**
			[0.133]			[0.133]
Share of Married Women Age 30-34			-0.242			-0.191
			[0.208]			[0.191]
Share of Married Men Age 35-39			0.384*			0.427*
			[0.214]			[0.226]
Share of Married Women Age 35-39			-0.0552			-0.0755
			[0.276]			[0.260]

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Constant	-0.805	-0.846	-0.759	0.372	0.328	0.339
	[0.517]	[0.511]	[0.532]	[0.632]	[0.636]	[0.624]
Within R2	0.8	0.75	0.76	0.8	0.76	0.77
F-stat	47.3	45.85	47.17	60.5	53.70	59.04
Prob > F-stat	0.0	0.00	0.00	0.0	0.00	0.00
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81	81	81
Observations	486	486	486	486	486	486

Note: This table reports the full results of Table 4. All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 5: Determinants of the fertility decline in France – spatial regressions

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t)			
Emigrants' Residence Norm (t)	0.468***	0.358***	0.395***	0.646***
	[0.0964]	[0.0996]	[0.121]	[0.168]
Immigrants' Birthplace Norm (t)	0.0227	-0.134	0.807***	0.233
	[0.115]	[0.0960]	[0.196]	[0.196]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-1.892***	-1.376**	-1.892***	-2.859***
	[0.492]	[0.535]	[0.616]	[0.728]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	2.110**	2.572***	0.337	0.850
	[0.904]	[0.760]	[1.280]	[0.693]
Share of Emigrants (t)	-3.098***	-1.826**	-2.589***	-3.685***
	[0.793]	[0.803]	[0.944]	[1.086]
Share of Immigrants (t)	3.993***	4.482***	1.272	1.772**
	[1.223]	[1.019]	[1.844]	[0.876]
Life Expectancy Age 15 (t)		0.0122***		0.00945***
		[0.00205]		[0.00230]
Infant Mortality (t)		1.294***		1.166***
		[0.162]		[0.177]
Urban (t)		0.0119		0.307
		[0.247]		[0.216]
Industries (t)		-0.00808**		-0.00420
		[0.00373]		[0.00321]
Professionals (t)		0.0161**		0.00875
		[0.00727]		[0.00957]
Female Education (t)		-0.0353		-0.0125
		[0.0336]		[0.0346]
Male Education (t)		0.0198		0.0412
		[0.0395]		[0.0439]
Share of Girls in Primary Catholic Schools (t)		0.00104		0.0166
		[0.0170]		[0.0199]
Share of Boys in Primary Catholic Schools (t)		-0.00271		0.00471
		[0.0157]		[0.0145]
ρ	2.630***	2.492***	1.030	1.703***
	[0.302]	[0.335]	[0.629]	[0.536]
σ^2	0.00474***	0.00337***	0.00475***	0.00330***
	[0.000544]	[0.000343]	[0.000530]	[0.000330]
Within R2	0.6	0.7	0.6	0.8
Log-pseudolikelihood	607.6	690.6	610.2	698.0
Year-fixed effects	Yes	Yes	Yes	Yes
Département-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81
Observations	486	486	486	486

Note: This table reports spatial autoregressive regressions with fixed effects using the xsmle Stata command (Belotti et al., 2013) for the regressions in Table 2. The great-circle distance is used as a distance measure All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 6: The fertility decline in France, 1861-1911: only male migration

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t)			
Emigrants' Residence Norm (t)	0.478***	0.365***	0.409	0.822***
	[0.118]	[0.0920]	[0.314]	[0.293]
Immigrants' Birthplace Norm (t)	0.0500	-0.136*	1.257***	0.329
	[0.109]	[0.0793]	[0.256]	[0.276]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-1.248**	-1.043**	-2.903***	-2.851***
	[0.534]	[0.450]	[0.788]	[0.724]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	1.239	2.108***	-0.328	0.830
	[0.854]	[0.604]	[1.333]	[0.847]
Share of Emigrants (t)	-2.094**	-1.588**	-4.000***	-3.809***
	[0.830]	[0.628]	[1.219]	[1.109]
Share of Immigrants (t)	2.688**	3.520***	0.658	1.518
	[1.156]	[0.808]	[1.872]	[1.084]
Life Expectancy Age 15 (t)		-0.00690		-0.00980
		[0.00901]		[0.0105]
Infant Mortality (t)		0.761**		0.592*
		[0.302]		[0.346]
Urban (t)		-0.139		0.129
		[0.316]		[0.303]
Industries (t)		-0.0124		-0.00194
		[0.00759]		[0.00699]
Professionals (t)		-0.0184		-0.00676
		[0.0131]		[0.0128]
Female Education (t)		-0.0337		-0.0301
		[0.0390]		[0.0393]
Male Education (t)		-0.00351		0.00969
		[0.0447]		[0.0496]
Share of Girls in Primary Catholic Schools (t)		0.00985		0.0130
		[0.0179]		[0.0205]
Share of Boys in Primary Catholic Schools (t)		-0.00290		0.00743
		[0.0161]		[0.0150]
Constant	-0.601***	-0.967*	0.720**	0.371
	[0.195]	[0.502]	[0.303]	[0.631]
Within R2	0.6	0.75	0.7	0.76
F-stat	41.7	50.69	38.7	55.72
Prob > F-stat	0.0	0.00	0.0	0.00
Year-fixed effects	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81
Observations	486	486	486	486

Note: All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 7: The fertility decline in France, 1861-1911: only female migration

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t)			
Emigrants' Residence Norm (t)	0.493***	0.294***	0.249	0.686**
	[0.136]	[0.103]	[0.316]	[0.304]
Immigrants' Birthplace Norm (t)	0.00404	-0.151*	1.356***	0.474
	[0.120]	[0.0834]	[0.273]	[0.299]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-1.980***	-1.187*	-2.917***	-2.891***
	[0.685]	[0.603]	[0.907]	[0.784]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	2.595***	3.126***	0.392	1.348*
	[0.968]	[0.684]	[1.320]	[0.780]
Share of Emigrants (t)	-3.362***	-1.794*	-4.033***	-3.804***
	[1.201]	[1.032]	[1.401]	[1.192]
Share of Immigrants (t)	4.655***	4.803***	1.665	2.068**
	[1.267]	[0.928]	[1.781]	[0.952]
Life Expectancy Age 15 (t)		-0.00686		-0.00631
		[0.0106]		[0.0107]
Infant Mortality (t)		0.759**		0.740**
		[0.335]		[0.348]
Urban (t)		-0.110		0.166
		[0.338]		[0.294]
Industries (t)		-0.0121		-0.00386
		[0.00771]		[0.00701]
Professionals (t)		-0.00778		-0.00621
		[0.0149]		[0.0124]
Female Education (t)		-0.0717		-0.0123
		[0.0452]		[0.0412]
Male Education (t)		0.0172		0.00707
		[0.0534]		[0.0504]
Share of Girls in Primary Catholic Schools (t)		-0.00160		0.0203
		[0.0191]		[0.0220]
Share of Boys in Primary Catholic Schools (t)		0.0103		0.00182
		[0.0156]		[0.0158]
Constant	-0.613***	-1.038*	0.644**	0.184
	[0.201]	[0.600]	[0.282]	[0.631]
Within R2	0.6	0.73	0.7	0.76
F-stat	39.1	52.00	41.3	63.80
Prob > F-stat	0.0	0.00	0.0	0.00
Year-fixed effects	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	81	81	81	81
Observations	486	486	486	486

Note: All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 8: The fertility decline in France, 1861-1911, excluding migration to and from Seine (Paris and suburbs)

	(1)	(2)	(3)	(4)
	OLS	OLS	IV	IV
	Dependent variable is Fertility(t)			
Emigrants' Residence Norm (t)	0.399***	0.293***	0.916**	0.467
	[0.129]	[0.105]	[0.435]	[0.406]
Immigrants' Birthplace Norm (t)	0.0850	-0.162	0.545	0.499
	[0.158]	[0.112]	[0.402]	[0.371]
Emigrants' Residence Norm (t) * Share of Emigrants(t)	-0.557	-0.840	-2.521	-2.634*
	[0.837]	[0.654]	[1.713]	[1.520]
Immigrants' Birthplace Norm (t)* Share of Immigrants (t)	2.337*	3.339***	1.658	2.055*
	[1.283]	[0.878]	[1.527]	[1.156]
Share of Emigrants (t)	-1.172	-1.390	-3.574	-3.524
	[1.321]	[0.954]	[2.670]	[2.332]
Share of Immigrants (t)	4.136**	5.102***	3.875*	3.518**
	[1.780]	[1.241]	[2.274]	[1.737]
Life Expectancy Age 15 (t)		-0.00211		-0.00345
		[0.00986]		[0.0104]
Infant Mortality (t)		0.864***		0.755**
		[0.320]		[0.347]
Urban (t)		-0.146		-0.00232
		[0.337]		[0.340]
Industries (t)		-0.0118		-0.00541
		[0.00796]		[0.00807]
Professionals (t)		-0.0168		-0.0127
		[0.0134]		[0.0130]
Female Education (t)		-0.0489		-0.0184
		[0.0423]		[0.0420]
Male Education (t)		-0.00369		-0.000684
		[0.0480]		[0.0515]
Share of Girls in Primary Catholic Schools (t)		0.00122		0.000856
		[0.0188]		[0.0202]
Share of Boys in Primary Catholic Schools (t)		0.00403		0.0112
		[0.0160]		[0.0148]
Constant	-0.674***	-1.329**	0.449	-0.214
	[0.236]	[0.570]	[0.407]	[0.713]
Within R2	0.6	0.74	0.7	0.75
F-stat	39.2	47.41	47.6	50.40
Prob > F-stat	0.0	0.00	0.0	0.00
Year-fixed effects	Yes	Yes	Yes	Yes
Department-fixed effects	Yes	Yes	Yes	Yes
Number of clusters	80	80	80	80
Observations	480	480	480	480

Note: All the variables are in logarithms. Robust standard errors clustered at the department-level are reported in brackets. *** indicates significance at the 1% level, ** at the 5%-level, * at the 10%-level.

Table 9. Actual, predicted and counterfactual fertility rates in France, 1861-1911

	OLS						IV					
	1861	1871	1881	1891	1901	1911	1861	1871	1881	1891	1901	1911
	No Changes in Migration after 1861						No Change in Migration after 1861					
Actual Data	0.310	0.287	0.293	0.254	0.254	0.244	0.310	0.287	0.293	0.254	0.254	0.244
	[0.061]	[0.063]	[0.065]	[0.049]	[0.043]	[0.037]	[0.061]	[0.063]	[0.065]	[0.049]	[0.043]	[0.037]
Basic Model (Predicted Values)	0.308	0.282	0.288	0.250	0.251	0.241	0.308	0.282	0.288	0.250	0.251	0.241
	[0.047]	[0.032]	[0.031]	[0.020]	[0.017]	[0.008]	[0.043]	[0.034]	[0.032]	[0.023]	[0.021]	[0.013]
Counterfactual fertility in France	0.308	0.294	0.294	0.267	0.268	0.264	0.308	0.316	0.313	0.300	0.299	0.293
under no changes in migration after 1861	[0.047]	[0.036]	[0.038]	[0.031]	[0.029]	[0.023]	[0.043]	[0.035]	[0.038]	[0.033]	[0.030]	[0.024]
Counterfactual fertility in France	0.308	0.280	0.281	0.248	0.245	0.238	0.308	0.292	0.295	0.273	0.272	0.265
under no changes in immigration after 1861	[0.047]	[0.034]	[0.035]	[0.027]	[0.025]	[0.017]	[0.043]	[0.035]	[0.035]	[0.027]	[0.025]	[0.016]
Counterfactual fertility in France	0.308	0.296	0.301	0.269	0.273	0.267	0.308	0.305	0.305	0.275	0.276	0.266
under no changes in emigration after 1861	[0.047]	[0.034]	[0.034]	[0.023]	[0.020]	[0.013]	[0.043]	[0.034]	[0.035]	[0.028]	[0.026]	[0.017]
Pearson X^2	0.558	0.839	0.880	0.578	0.581	0.493	0.485	0.736	0.817	0.562	0.534	0.429
	No Changes in Female Migration after 1861						No Changes in Female Migration after 1861					
Basic Model (Predicted Values)	0.308	0.282	0.288	0.250	0.251	0.241	0.308	0.282	0.288	0.250	0.251	0.241
	[0.044]	[0.029]	[0.029]	[0.018]	[0.015]	[0.008]	[0.043]	[0.033]	[0.032]	[0.023]	[0.021]	[0.013]
Counterfactual fertility in France	0.308	0.290	0.290	0.260	0.260	0.254	0.308	0.316	0.313	0.303	0.302	0.295
under no changes in female migration after 1861	[0.044]	[0.031]	[0.033]	[0.025]	[0.024]	[0.017]	[0.043]	[0.035]	[0.038]	[0.033]	[0.030]	[0.023]
Pearson X^2	0.529	0.778	0.812	0.547	0.547	0.457	0.475	0.723	0.800	0.549	0.5206699	0.414
	No Changes in Male Migration after 1861						No Changes in Male Migration after 1861					
Basic Model (Predicted Values)	0.308	0.282	0.288	0.250	0.251	0.241	0.308	0.282	0.288	0.250	0.251	0.241
	[0.044]	[0.030]	[0.028]	[0.019]	[0.016]	[0.009]	[0.043]	[0.034]	[0.032]	[0.024]	[0.021]	[0.012]
Counterfactual fertility in France	0.308	0.292	0.292	0.262	0.262	0.257	0.308	0.315	0.312	0.298	0.297	0.290
under no changes in male migration after 1861	[0.044]	[0.033]	[0.034]	[0.027]	[0.025]	[0.018]	[0.043]	[0.036]	[0.038]	[0.033]	[0.030]	[0.024]
Pearson X^2	0.521	0.798	0.813	0.580	0.562	0.488	0.489	0.735	0.820	0.568	0.541	0.442
	No changes in migration from and to Paris after 1861						No changes in migration from and to Paris after 1861					
Basic Model (Predicted Values)	0.307	0.283	0.288	0.250	0.251	0.242	0.307	0.283	0.288	0.250	0.252	0.242
	[0.041]	[0.028]	[0.025]	[0.018]	[0.014]	[0.008]	[0.041]	[0.029]	[0.028]	[0.021]	[0.018]	[0.011]
Counterfactual fertility in France under no changes	0.307	0.288	0.290	0.264	0.264	0.259	0.307	0.300	0.302	0.291	0.285	0.276
in migration from and to Paris after 1861	[0.041]	[0.030]	[0.030]	[0.024]	[0.021]	[0.015]	[0.041]	[0.031]	[0.033]	[0.029]	[0.025]	[0.019]
Pearson X^2	0.491	0.706	0.772	0.528	0.490	0.433	0.499	0.697	0.840	0.572	0.512	0.426

Note: This table reports the mean an standard deviation at the national level for the actual, predicted and counterfactual values under the assumption that no changes in fertility norms and in the shares of migrants had occurred after 1861 at the national level using the OLS and IV regression results with the control variables in Columns 2 and 4 of Tables 2, 5, 6 and 7. The counterfactual values obtained from the IV regression results are graphed in Figure 3.

For Online Publication -- Supplementary Appendix

Supplementary Appendix A. **Table A1: Descriptive statistics**

	Mean	Std.Dev	Min	Max
Inhabitants' Residence Norm	0.274	0.059	0.158	0.566
Fertility Norms and Share of Emigrants - Full Sample				
Emigrants' Residence Norm	0.257	0.038	0.169	0.390
Immigrants' Birthplace Norm	0.273	0.035	0.203	0.398
Share of Emigrants	0.173	0.076	0.032	0.495
Share of Immigrants	0.127	0.087	0.006	0.589
Fertility Norms and Share of Emigrants - Female Sample				
Emigrants' Residence Norm	0.255	0.038	0.158	0.361
Immigrants' Birthplace Norm	0.273	0.039	0.199	0.463
Share of Emigrants	0.164	0.076	0.022	0.471
Share of Immigrants	0.119	0.087	0.002	0.583
Fertility Norms and Share of Emigrants - Male Sample				
Emigrants' Residence Norm	0.259	0.041	0.172	0.469
Immigrants' Birthplace Norm	0.273	0.038	0.183	0.425
Share of Emigrants	0.182	0.079	0.039	0.519
Share of Immigrants	0.136	0.089	0.009	0.616
Fertility Norms and Share of Emigrants - Excluding Paris				
Emigrants' Residence Norm	0.266	0.037	0.169	0.439
Immigrants' Birthplace Norm	0.275	0.034	0.203	0.398
Share of Emigrants	0.130	0.065	0.029	0.494
Share of Immigrants	0.114	0.064	0.006	0.402
Education, health and the workforce				
Life Expectancy at Age 15	48.724	7.553	34.759	65.915
Infant Mortality (under age 1, in %)	0.217	0.108	0.019	0.626
Urban (% residents living in jurisdictions of more than 2,000 inhabitants)	0.280	0.162	0.082	1.000
Industries (% of the workforce in the industrial sector)	0.211	0.134	0.001	0.677
Professionals (% of professionals, e.g. lawyers, doctors..., in workforce)	0.027	0.016	0.001	0.160
Female Education (% 5-19 year old females in primary and secondary schools)	0.499	0.136	0.075	0.792
Male Education (% 5-19 year old males in primary and secondary schools)	0.528	0.129	0.149	1.071
Share of girls in Catholic primary schools (in %, out of the total number of girls in Catholic and secular primary schools)	0.437	0.182	0.026	0.939
Share of boys in Catholic primary schools (in %, out of the total number of boys in Catholic and secular primary schools)	0.166	0.122	0.010	0.727
Variables for robustness checks				
Total Number of Periodicals	51.309	253.449	2	4021
Share of Children Born out of Wedlock out of the Total Number of Births	0.063	0.055	0	1
Share of not legitimized Children out of those who were Born out of Wedlock	0.664	0.185	0.095	1
Share of Married Men Age 20-24	0.119	0.056	0.021	0.431
Share of Married Women Age 20-24	0.462	0.142	0.172	0.899
Share of Married Men Age 25-29	0.488	0.113	0.072	0.871
Share of Married Women Age 25-29	0.699	0.091	0.277	0.868
Share of Married Men Age 30-34	0.678	0.132	0.248	0.860
Share of Married Women Age 30-34	0.772	0.070	0.472	0.968
Share of Married Men Age 35-39	0.768	0.094	0.345	0.919
Share of Married Women Age 35-39	0.786	0.065	0.535	1.333

Note: there are 486 observations for each variable.

Supplementary Appendix B: Fertility rates and fertility convergence in France, England & Wales, Germany and Italy.

Figure B1: Fertility rates in France, England, Germany and Italy

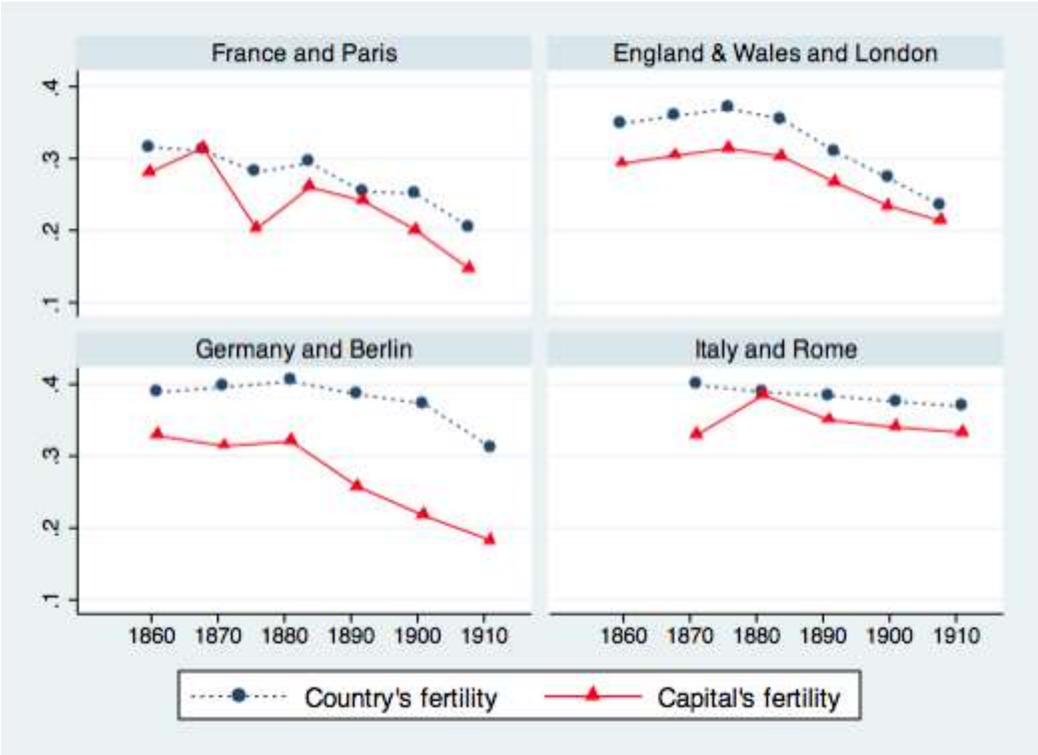


Figure B2: Fertility distribution in England and Wales, 1861-1911

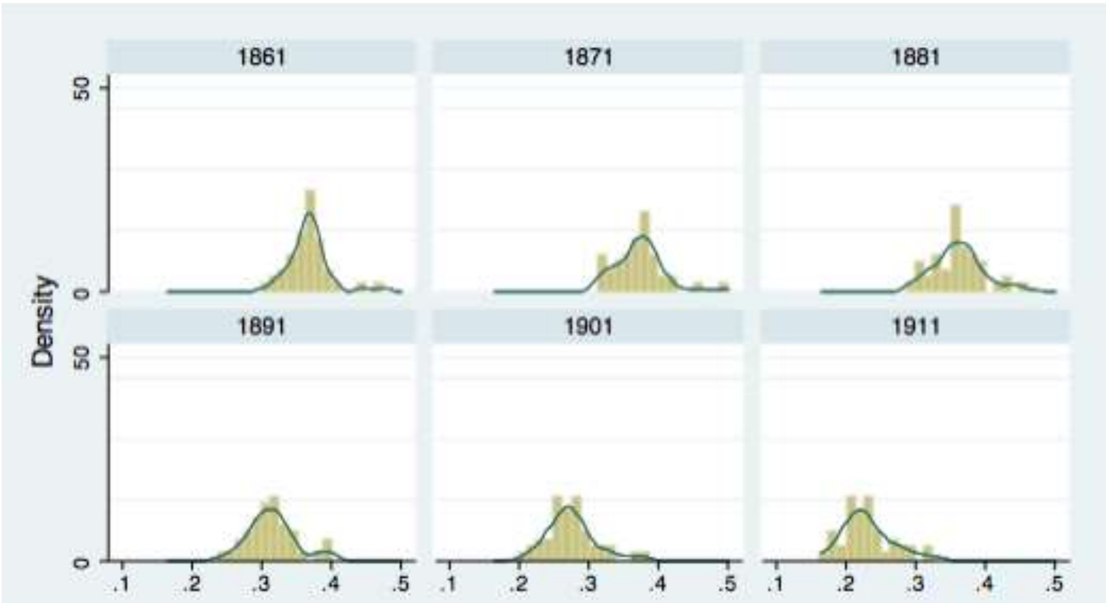


Figure B3: Fertility distribution in Germany, 1871-1910

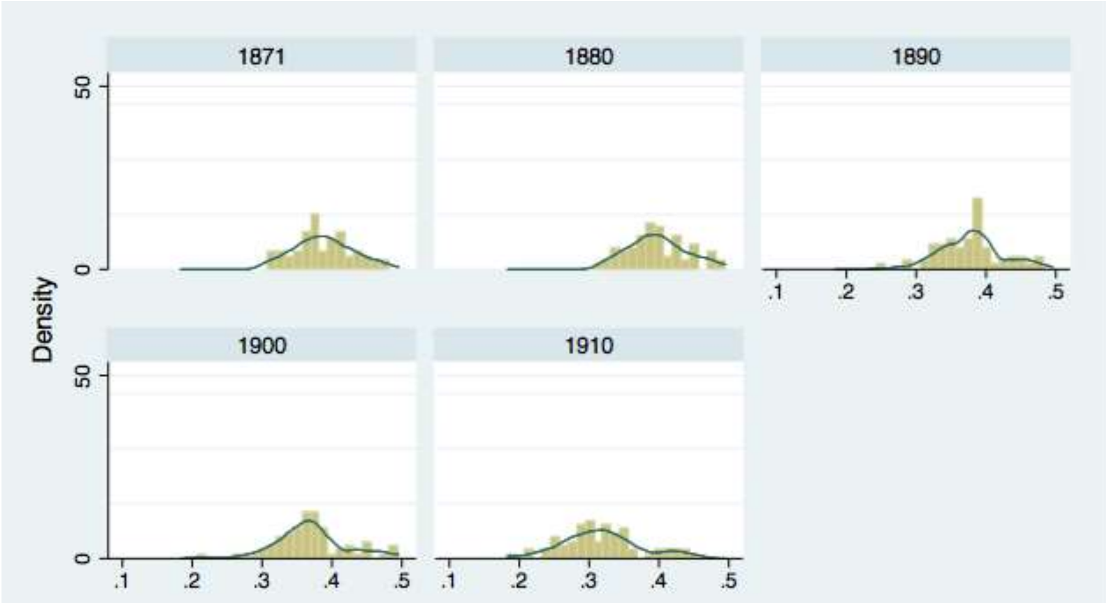
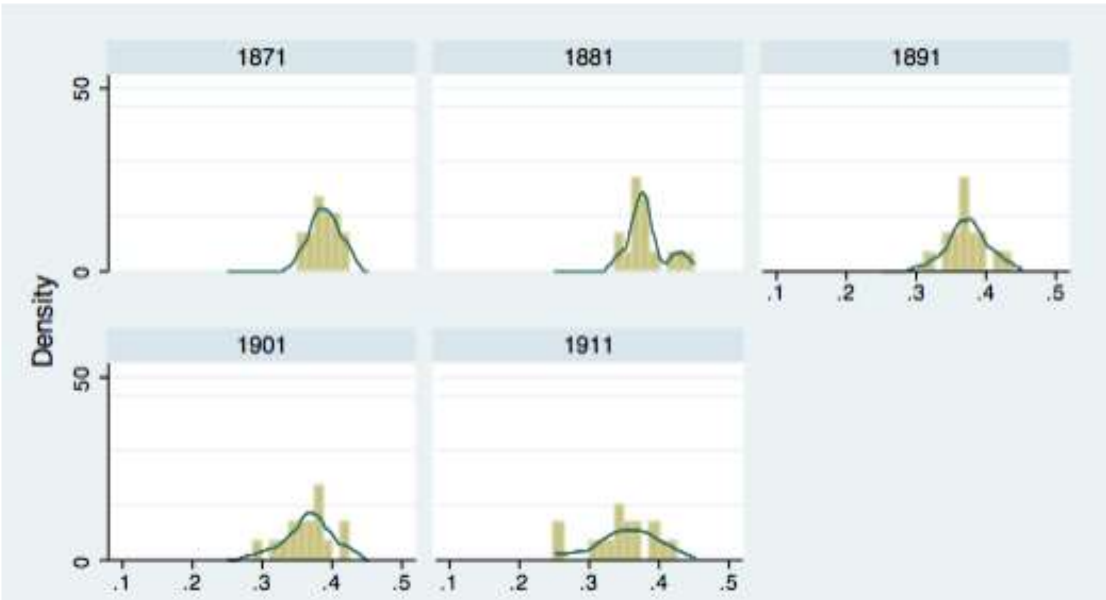


Figure B4: Fertility distribution in Italy, 1871-1910



Note: These Figures graph the Fertility Coale Indices of France, England & Wales, Germany and Italy with their respective capitals. In all the countries, the capital's fertility is lower than that of the whole country. The Figure shows that there is a secular decline in fertility in France during the 19th century. However the fertility decline in England & Wales and Germany only begins after 1880 while it does not seem to occur in Italy before WWI. Moreover there was almost no convergence in the fertility rates across the regions of England & Wales, Germany and Italy before WWI

Sources: Bonneuil (1997) and authors' computation for 1911 for France. Princeton Project on the Decline of Fertility in Europe for the other countries.

Supplementary Appendix C. Unconditional convergence test of fertility decline

Following our discussion in Section 2, where we discuss the convergence in the fertility levels across the French departments, we run a series of unconditional convergence regressions that follow (Barro and Sala-i-Martin 1992)'s approach:

$$\log\left(\frac{f_{i,t+10}}{f_{i,t}}\right) = a.\log(f_{i,t}) + time\ fixed\ effects + \varepsilon \qquad (1)$$

The results of this regression are reported in Table C.1 for France, England and Wales, Italy and Germany. They show that the convergence of the regional fertility rates is a specific French feature.

Supplementary Table C.1: Unconditional convergence test of fertility

Dependent variable is $\left(f_{i,t+10}/f_{i,t}\right)$

	France (1851-1911)	England and Wales (1851-1911)	Germany (1871-1910)	Italy (1871-1910)
$(f_{i,t})$	-0.17***	0.07**	0.07**	0.20
	[0.02]	[0.03]	[0.03]	[0.11]
Year= 1861	-0.02	-0.03***		
	[0.01]	[0.01]		
Year= 1871	0.08***	-0.07***		
	[0.01]	[0.01]		
Year= 1881	-0.08***	-0.18***	-0.08***	-0.00
	[0.01]	[0.01]	[0.01]	[0.02]
Year= 1891	0.03**	-0.17***	-0.05***	0.00
	[0.01]	[0.01]	[0.01]	[0.02]
Year= 1901	-0.01	-0.20***	-0.18***	-0.02
	[0.02]	[0.01]	[0.01]	[0.02]
Constant	-0.26***	0.11***	-0.09***	-0.17
	[0.2]	[0.03]	[0.03]	[0.11]
Observations	520	276	284	64
R^2	0.34	0.81	0.59	0.09

Note: All variables are in logarithms. Robust standard errors clustered at the region level are reported. Sources: The regressions rely on the Fertility Coale Indices of France, England & Wales, Germany and Italy. See text for France. Princeton Project on the Decline of Fertility in Europe for the other countries.

Supplementary Appendix D. The TRA data and the computation of the total number of emigrants and immigrants at the département level with the RAS technique

This Appendix discusses how the bilateral migration TRA data can be transformed to reflect the total number of emigrants and immigrants at the *département* level with a standard marginalization algorithm known as the RAS technique.

The first step is to compute the implied bilateral migrant stocks in any given year from the TRA data. For this purpose, we assume that people who died in a different *département* from their birth *département* migrated at age 20.[30] This provides us with $m_{ij,t}^{TRA}$ which is the number of migrants from *département* i living in département j in each year t (with t=1861, 1872, 1881, 1891, 1901 and 1911) in the TRA dataset.

The second step is to gather the number of domestic immigrants and emigrants from each *département* from the census. These data are published in the 1891, 1901 and 1911 issues of the French census. In the issues of the census published in 1861, 1872 and 1881, the number of immigrants is given as the number of individuals in each *département* who were born in another *département*. We can then compute the number of emigrants using information on birth rates, mortality rates, the number of inhabitants and the number of emigrants published in the next issue of the census.[31] This provides us with $m_{i.,t}^{Census}$ and $m_{.j,t}^{Census}$which are respectively the total number domestic emigrants from each *département* i and immigrants in each *département* j for each year.

Our third stage is to transform the TRA dataset so as to obtain a matrix which is defined by the margins coming from the census and the odds ratios (the ratio between, for example, the odds of an immigrant in *département* A to be an emigrant from *département* B instead of being from C and the odds of an immigrant in *département* D to be an emigrant from *département* B instead of being from C) coming from the TRA (See (Smith 1976), p. 672-3). For this purpose, we apply a marginal standardization algorithm known as the RAS technique (see (Smith 1976) and (Cox 2006)'s software).[32] This is meant to reconcile the bilateral matrix composed of $m_{ij,t}^{TRA}$with its margins composed of $m_{i.,t}^{Census}$ and $m_{.j,t}^{Census}$, or find the $m_{ij,t}^{RAS}$ such as $\sum_i m_{ij,t}^{RAS} = m_{.j,t}^{Census}$ and $\sum_j m_{ij,t}^{RAS} = m_{i.,t}^{Census}$ and $m_{ij,t}^{RAS}$ is “close” to $m_{ij,t}^{TRA}$. The algorithm works by multiplying by a scalar alternatively the lines and the columns of the matrix so that $\sum_i m_{ij,t}^{k^{th}\ iteration} = m_{.j,t}^{Census}$ or $\sum_j m_{ij,t}^{k^{th}\ iteration} = m_{i.,t}^{Census}$. This goes on till the sums of both the lines and column are nearly equal to the pre-defined margins.

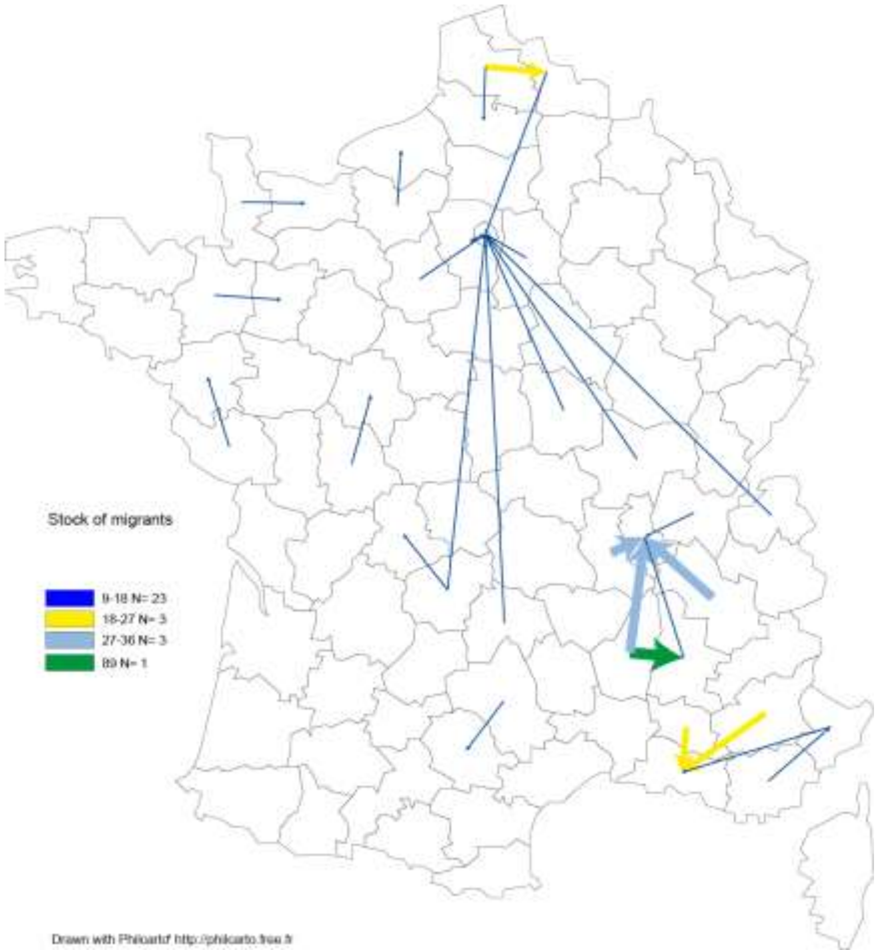
[30] This assumption is based on computations of thecourse an approximation. Using net positive migration rates by age using data from (Bonneuil 1997), we computed that the mean age at migration was 19.4 years in 1861, 18.6 in 1872, 22.5 in 1881 and, 21.4 in 1891.

[31] For simplicity we ignore emigration to foreign countries – which was anyway small - and the small number of emigrants from Alsace-Lorraine (which was seized by Germany after 1871) by assuming they were a fixed proportion of emigrants in each *département* throughout the country.

[32] This procedure is also known as biproportional matrices, iterative proportional fitting or raking.

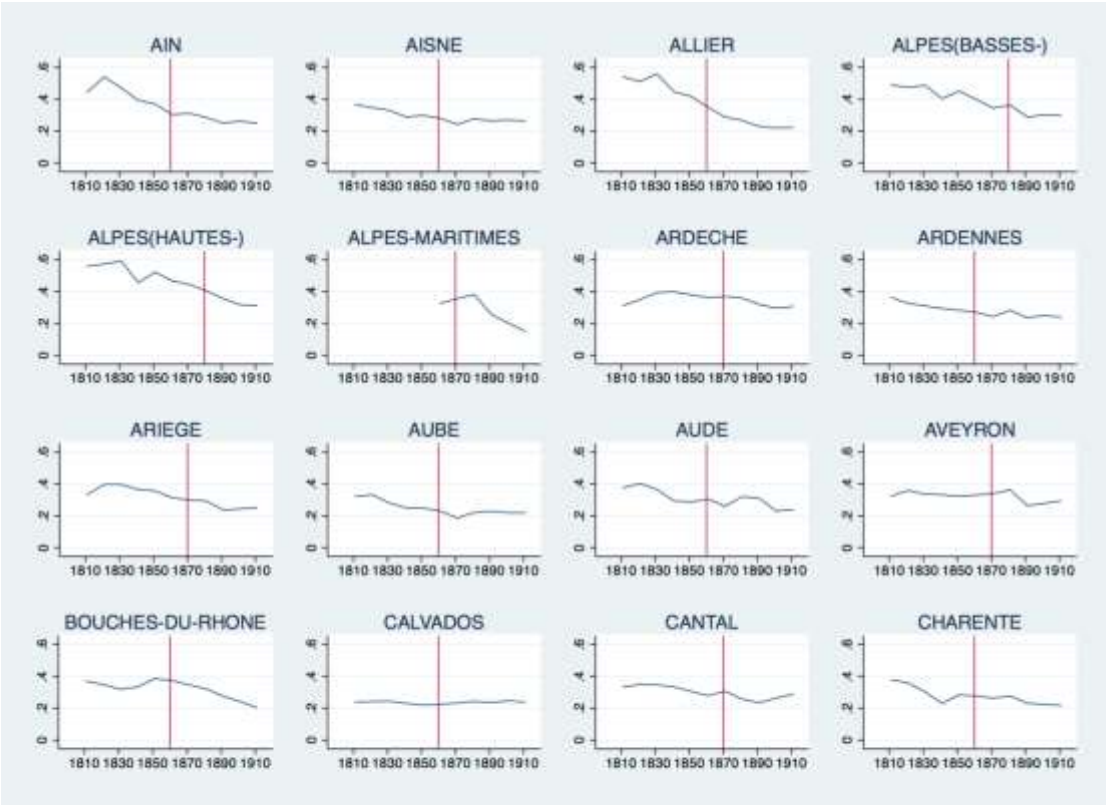
These transformed TRA data then become our main measure of bilateral migration. A similar procedure is used to compute male and female migration, except that the gender differentiated margins for 1891 have to be extrapolated from the 1881 and the 1901 census.

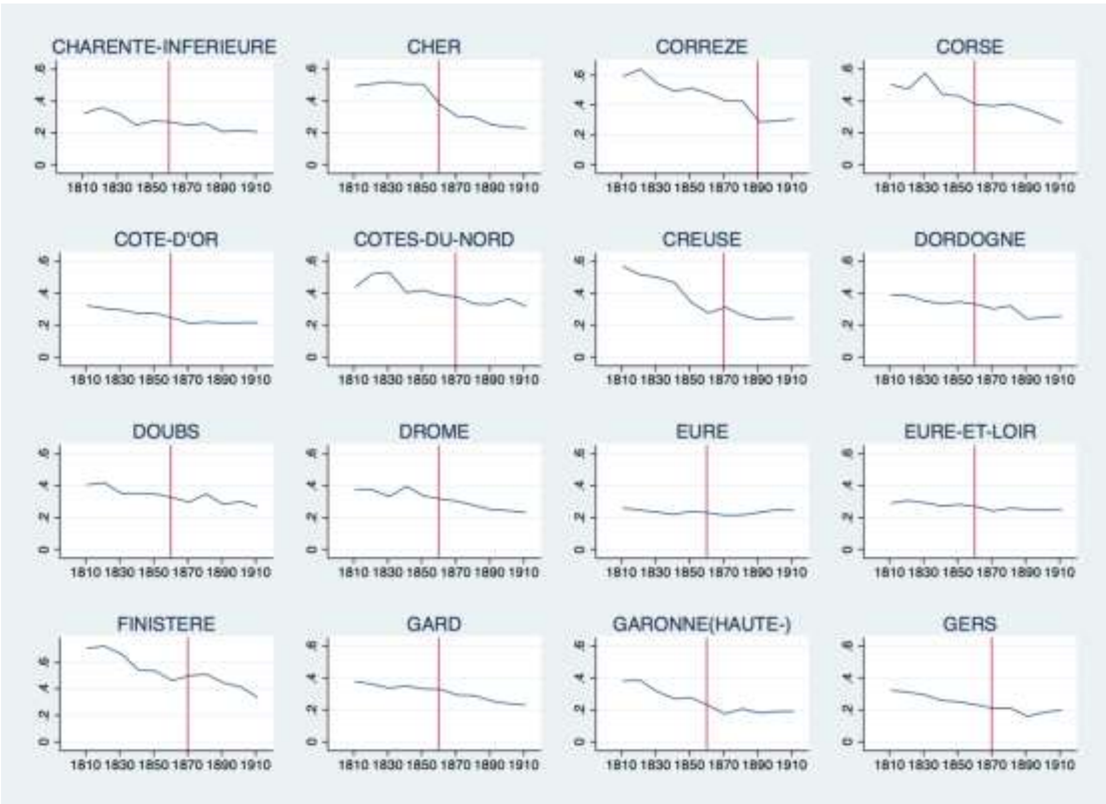
Figure D1: Bilateral migrant stocks > 11, TRA data, 1891

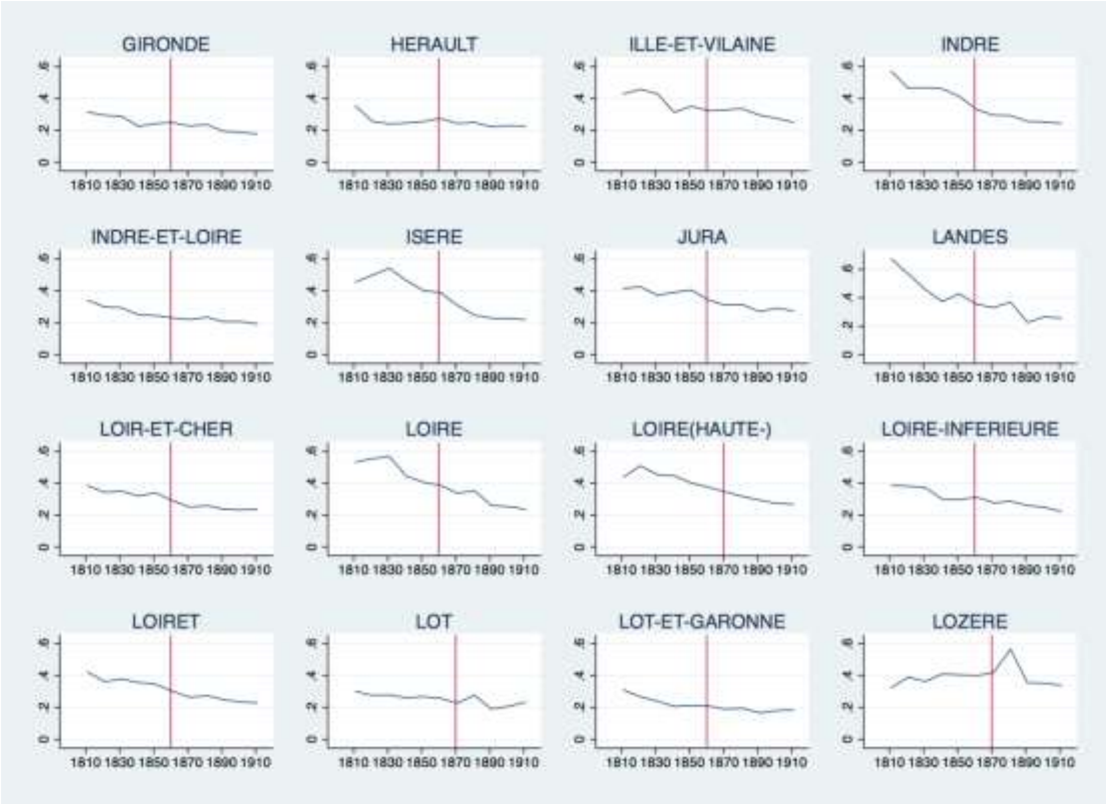


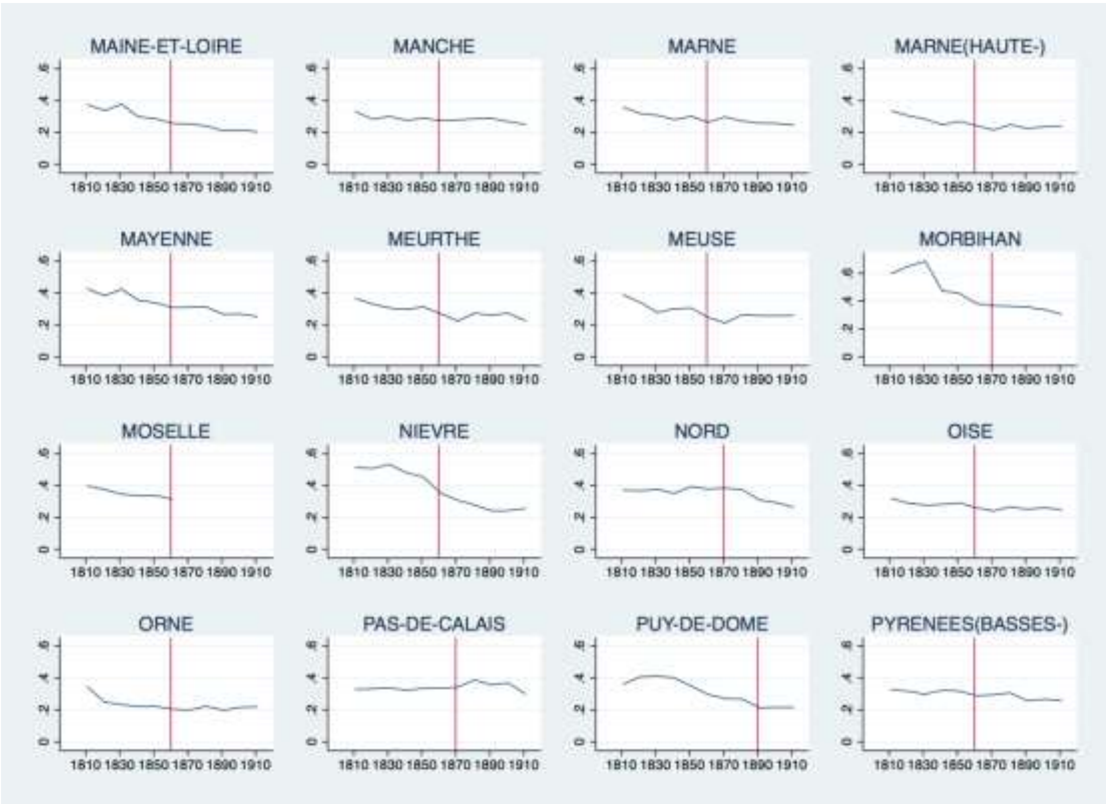
Note: In the legend, the first two numbers represent the bounds of the bracket for the stock of migrants; N represents the number of links between *départements* in each bracket.

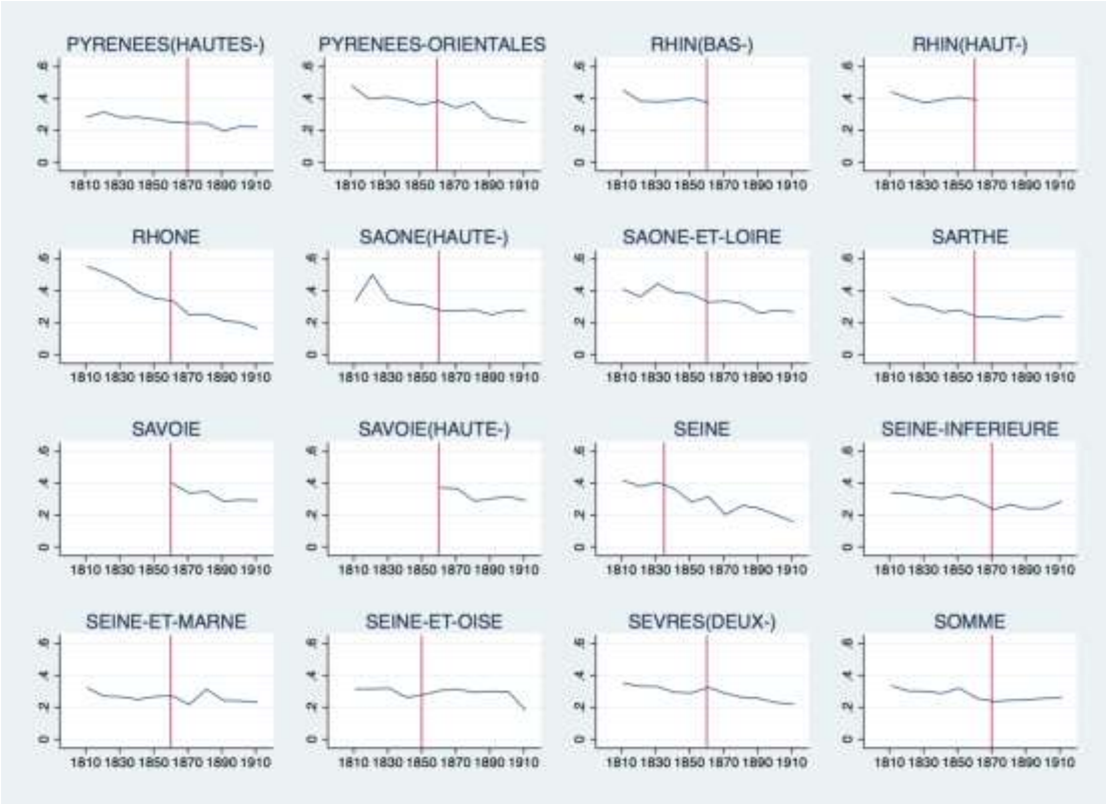
Supplementary Appendix E: Fertility rates and the railroad network, 1811-1911.

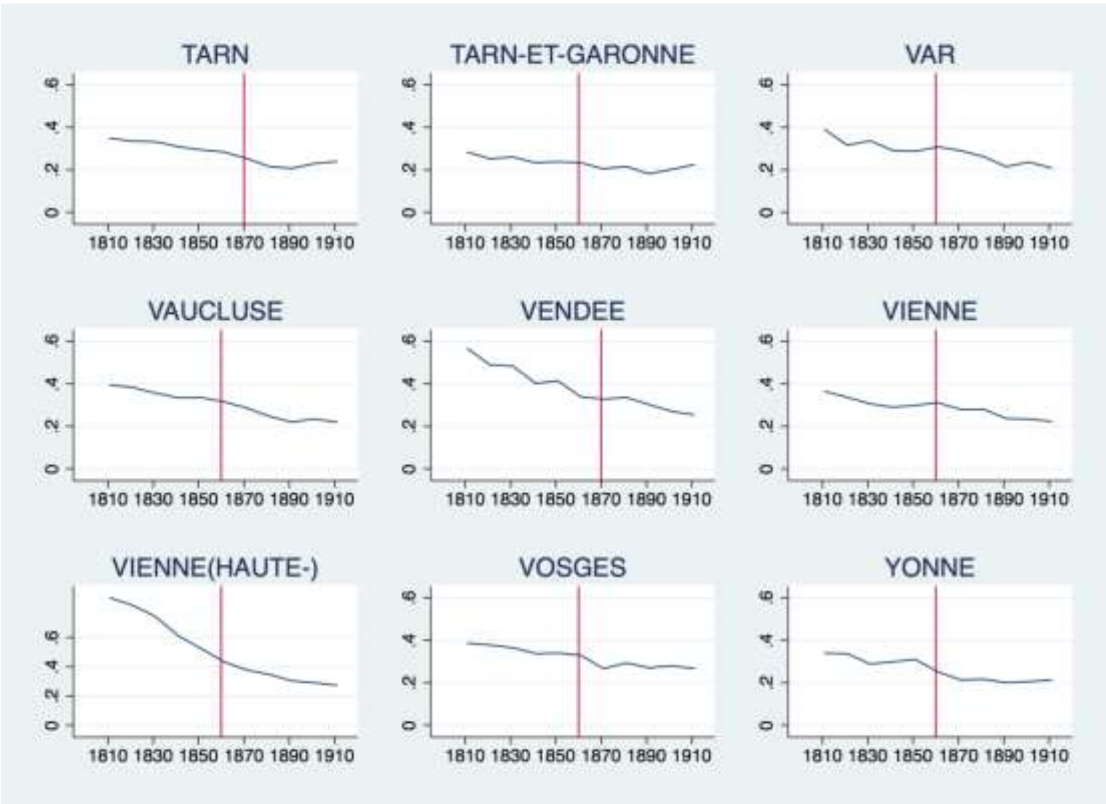





GIRONDE
HERAULT
ILLE-ET-VILAINE
INDRE
INDRE-ET-LOIRE
ISERE
JURA
LANDES
LOIR-ET-CHER
LOIRE
LOIRE(HAUTE-)
LOIRE-INFERIEURE
LOIRET
LOT
LOT-ET-GARONNE
LOZERE
1810 1830 1850 1870 1890 1910


MAINE-ET-LOIRE
MANCHE
MARNE
MARNE(HAUTE-)
MAYENNE
MEURTHE
MEUSE
MORBIHAN
MOSELLE
NIEVRE
NORD
OISE
ORNE
PAS-DE-CALAIS
PUY-DE-DOME
PYRENEES(BASSES-)
1810 1830 1850 1870 1890 1910





Note: The line corresponds to the year when the *département* was linked to Paris via the railroad network.

Source: For the Fertility Coale Index, see the text. See (Caron 1997) for the railroad network.

Supplementary Appendix F: The state of the development of the railroad network following the "L'etoile de Legrand" pattern in 1856.