

Franck, Raphaël; Galor, Oded

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# Industrialization and the Fertility Decline\*

Raphaël Franck<sup>†</sup> and Oded Galor<sup>‡</sup>

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## Abstract

The research provides the first empirical examination of the hypothesized effect of industrialization on the fertility decline. Exploiting exogenous source of regional variations in the adoption of steam engines across France, the study establishes that industrialization was a major catalyst in the fertility decline in the course of the demographic transition. Moreover, the analysis further suggests that the contribution of industrialization to the decline in fertility plausibly operated through the effect of industrialization on human capital formation. Thus, the study confirms one of the central elements of Unified Growth Theory which hypothesizes that a critical force in the transition from stagnation to growth was by the impact of industrialization on the onset of the demographic transition, via the rise in the demand for human capital.

**Keywords:** Economic Growth, Fertility Transition, Human Capital, Industrialization, Steam Engine.

**JEL classification:** J10, N33, N34, O14, O33.

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<sup>†</sup>Department of Economics, Bar-Ilan University, 52900 Ramat Gan, Israel & Marie Curie Fellow at the Department of Economics at Brown University. Tel: 972-3-531-8935, Fax: 972-3-738-4034, Raphael.Franck@biu.ac.il

<sup>‡</sup>Herbert H. Goldberger Professor of Economics, Brown University, Department of Economics, 64 Waterman St, Providence RI 02912 USA. Oded.Galor@brown.edu.

# 1 Introduction

The evolution of societies from an epoch of stagnation to an era of sustained economic growth has been largely viewed as one of the most dramatic transitions in the course of human history. While standards of living stagnated during the millennia prior to the Industrial Revolution, income per capita has experienced an unprecedented twelvefold increase over the past two centuries, transforming the distribution of the wealth of nations across the globe.

The demographic transition has been recently viewed as a pivotal element in the transition from stagnation to growth. Throughout most of human existence, the process of development was marked by Malthusian stagnation. Resources generated by technological progress and land expansion were channeled primarily toward population growth and had a negligible impact on the level of income per capita in the long run. The decline in population growth in the course of the demographic transition permitted economies to divert a larger share of the fruits of factor accumulation and technological progress to the enhancement of human capital formation and income per capita, thus paving the way for the emergence of sustained economic growth.

While one of the main elements of Unified Growth Theory hypothesizes that a critical force in the transition from stagnation to growth has been the impact of industrialization on the onset of the demographic transition (Galor and Weil, 2000; Galor and Moav, 2002; Galor and Mountford, 2008; Galor, 2011), this important aspect has not been tested directly. This research examines this unexplored effect of industrialization on the fertility decline. It exploits exogenous source of regional variations in the adoption of steam engines across France to establish that industrialization was indeed a major catalyst in the fertility decline in the course of the demographic transition. Moreover, in line with the predictions of Unified Growth Theory, the analysis further suggests that the contribution of industrialization to the decline in fertility plausibly operated through the effect of industrialization on human capital formation.

The study uses French regional data from the second half of the 19th century to explore the impact of the adoption of industrial technology on the fertility decline in the subsequent decades. It establishes that regions which industrialized earlier experienced a larger fertility decline. Nevertheless, the observed relationship between industrialization and the fertility decline may reflect the persistent effect of pre-industrial characteristics (e.g., economic, institutional and cultural forces) on the joint evolution of industrialization and fertility. Moreover, in light of the role of child labor in the early phases of industrialization, one may argue that the level of fertility may have affected the intensity of industrialization. Thus, the research exploits exogenous regional variations in the adoption of steam engines across France to assess the impact of industrialization on the decline in fertility.<sup>1</sup>

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<sup>1</sup>A steam engine was first used for industrial purposes in a coal mine near Wolverhampton (England) in 1712. In following decades, steam engines were gradually employed in various regions of continental Europe. See Mokyr (1990, p.85).

In light of the use of the steam engine in the early phase of industrialization (Mokyr, 1990; Bresnahan and Trajtenberg, 1995; Rosenberg and Trajtenberg, 2004), the study exploits the historical evidence regarding the regional diffusion of the steam engine (Ballot, 1923; Sée, 1925; Léon, 1976) to identify the impact of regional variations in the number of steam engines in 1860-1865 on the decline in fertility. It uses the distances between the administrative center of each French department and Fresnes-sur-Escaut, where a steam engine was first used for industrial purpose in 1732, as exogenous source of variations in industrialization across France.<sup>2</sup>

The study establishes that the number of steam engines in industrial production in the 1860-1865 period had a positive and significant impact on the decline in fertility in the 1870-1930 period. Moreover, the analysis further suggests that the contribution of industrialization to the decline in fertility plausibly operated through the effect of industrialization on human capital formation, rather than through the rise in income that was brought about by the process of industrialization, or the decline in mortality which took place over this time period.

The results of the empirical analysis are robust to the inclusion of a wide array of exogenous confounding geographical and institutional characteristics, as well as for pre-industrial development, which may have contributed to the relationship between industrialization and human capital formation. First, the study accounts for the potentially confounding impact of exogenous geographical characteristics of each French department on the relationship between industrialization and investments in education. It captures the potential effect of these geographical factors on the profitability of the adoption of the steam engine and the pace of its regional diffusion, as well as on productivity and human capital formation, as a by-product of the rise in income rather than as an outcome of technology-skill complementarity. Second, the analysis captures the potentially confounding effects of the location of departments (i.e., latitude, border departments, maritime departments, and the distance to Paris) on the diffusion of the steam engine and the diffusion of development (i.e., income and education). Third, the study accounts for the differential level of development across France in the pre-industrial era that may have had a joint impact on the process of industrialization and the formation of human capital. In particular, it takes into account the potentially confounding effect of the persistence of pre-industrial development and the persistence of pre-industrial literacy rates.

The remainder of this article proceeds as follows. Section 2 presents the data. Section 3 discusses the empirical strategy. Section 4 presents the main results and establishes their robustness to a wide range of confounding factors. Section 5 provides concluding remarks.

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<sup>2</sup>As we establish below, the diffusion of the steam engines across the French departments, i.e., the administrative divisions of the French territory created in 1790, is orthogonal to the distances between each department and Paris, the capital and economic center of the country.

## 2 Data

This section examines the evolution of industrialization and fertility across the French departments, based on the administrative division of France in the 1860-1865 period, accounting for the geographical and the institutional characteristics of these regions. The initial partition of the French territory in 1790 was designed to ensure that the travel distance by horse from any location within the department to the main administrative center would not exceed one day. The initial territory of each department was therefore orthogonal to the process of development and the subsequent minor changes in the borders of some departments did not reflect the effect of industrialization.

In light of the changes in the internal and external boundaries of the French territory during the period of study, the number of departments which is included in the various stages of the analysis varies from 82 to 85. In particular, several departments which were temporarily removed from the French territory are excluded from the analysis during those time periods.<sup>3</sup> Table A.1 reports the descriptive statistics for the variables in the empirical analysis across these departments.

### 2.1 Measures of Fertility, Income and Human Capital

#### 2.1.1 Fertility

The research examines the effect of industrialization in 1860-1865 on fertility in each department between 1871 and 1931. The fertility rate is captured by the Coale Fertility Index (Coale, 1969) which captures the ratio between the total fertility rate in each French department in a given year and the total fertility rate of the Hutterites, a strict religious group in Northern America with a high rate of fertility.

#### 2.1.2 Income

This study further explores the effect of industrialization on fertility via the evolution of income per capita. Since the industrial survey was conducted between 1860 and 1865, the relevant data to capture the impact of industrialization on income per capita are available at the departmental level for the following years: 1872, 1886, 1911 and 1930. (Combes et al., 2011; Caruana-Galizia, 2013).

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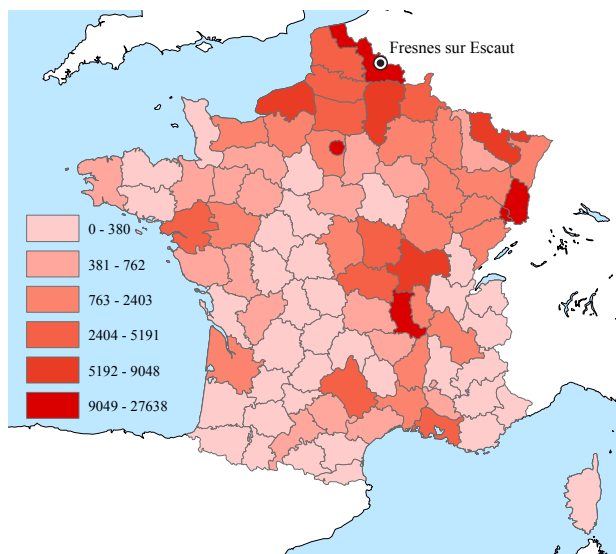
<sup>3</sup>The three departments (i.e., Bas-Rhin, Haut-Rhin and Meurthe) which were under German rule between 1871 and 1918 are excluded from the analysis of economic development over that time period. In addition, in the examination of the robustness of the analysis with data prior to 1860, the three departments (i.e., Alpes-Maritimes, Haute-Savoie and Savoie) that were not part of France are excluded from the analysis.

### 2.1.3 Human Capital

The study examines the effect of industrialization on fertility through the evolution of human capital in the process of development. The effect of early industrialization on human capital formation is captured by its impact on the share of French army conscripts (i.e., 20-year-old men who reported for military service in the department where their father lived) who were literate. Among these literate army conscripts, we can further distinguish those high-school graduates.

As reported in Table A.1, few Frenchmen completed high-school in our sample period: 0.2% of the French conscripts were high-school in 1872 and only 3.3% in 1931. While a sizeable share of the French population had become literate even before the passing of the 1881-1882 laws which made primary school attendance “free” and mandatory for boys and girls until age 13, few men (and even fewer women) graduated from high-school because basic literacy and numeracy skills were sufficient to find a job in most occupations. Completing high-school was reserved to those whose parents were willing and able to fund the “long-run” studies of their children

## 2.2 Steam Engines



**Figure 1:** The distribution of the total horse power of steam engines across departments in France, 1860-1865.

The research explores the impact of industrial technology on fertility. In light of the crucial role played by the steam engine in the process of industrialization, it exploits variations in the industrial use of the steam engine across the French departments during its early stages of industrialization to capture the intensity of industrialization. The empirical analysis focuses on the horse power of steam engines used in each department as reported in the industrial survey undertaken by the

French government between 1860 and 1865.<sup>4</sup>

As depicted in Figure 1, and analyzed further in the discussion of the identification strategy in Section 3, the distribution of the steam engines across French departments in 1860-1865 suggests a regional pattern of diffusion from Fresnes-sur-Escaut (in the Nord department, at the northern tip of continental France) where the first steam engine in France was introduced in 1732. In 1860-1865, the most intensive use of the steam engine was in the Northern part of France. The intensity diminished somewhat in the East and in the South East, and declined further in the South West.

## 2.3 Confounding Characteristics of each Department

The empirical analysis accounts for a wide range of exogenous confounding geographical and institutional characteristics, as well as for pre-industrial development, which may have contributed to the relationship between industrialization and economic development, and thus to the decline in fertility. Institutions may have affected jointly the process of industrialization and the process of development, contributing to the evolution of fertility rates. Geographical characteristics may have impacted the pace of industrialization as well as agricultural productivity, income per capita, and thus fertility. Moreover, geographical and institutional factors may have affected the process of development indirectly by governing the pace of the diffusion of steam engines across departments. Finally, pre-industrial development may have affected the onset of industrialization and may have had an independent persistent effect on the process of development and the evolution of fertility. Furthermore, pre-industrial fertility levels may have had a persistent effect on the evolution of fertility and the pace of fertility decline across regions.

### 2.3.1 Geographic Characteristics

The empirical analysis accounts for the potentially confounding impact of exogenous geographical characteristics of each of the French departments on the relationship between industrialization and economic development. In particular, it captures the potential effect of these geographical factors on the profitability of the adoption of the steam engine, the pace of its regional diffusion, as well as on productivity and thus the evolution of income per capita in the process of development.

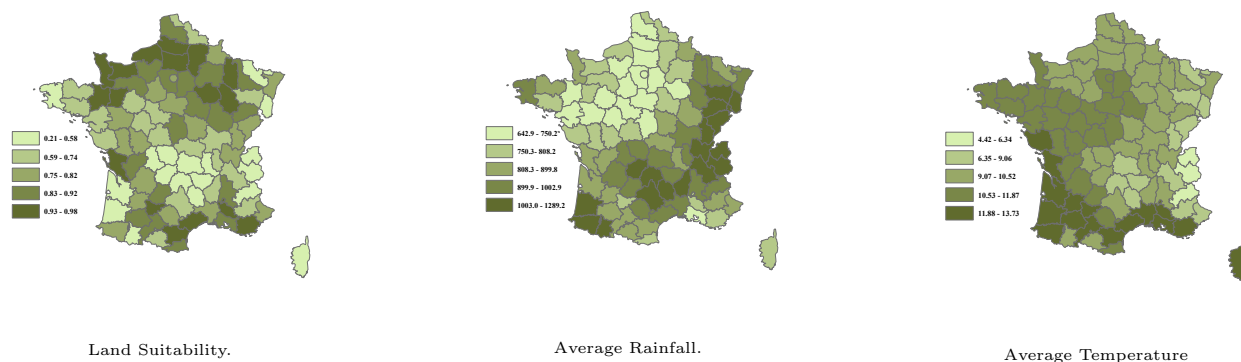
First, the study accounts for climatic and soil characteristics of each department mapped in Figure 2 (i.e., land suitability, average temperature, average rainfall, and latitude (Ramankutty et al., 2002)), that could have affected natural land productivity and therefore the feasibility and profitability of the transition to the industrial stage of development, as well as the evolution of aggregate productivity in each department.

Second, the analysis captures the confounding effect of the location of each department on

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<sup>4</sup>Chanut et al. (2000) discuss the implementation of this survey.

the diffusion of development from nearby regions or countries, as well as its effect on the regional diffusion of the steam engine. In particular, it accounts for the effect of the latitude of each department, border departments (i.e., positioned along the border with Belgium, Luxembourg, Germany, Switzerland, Italy and Spain), and maritime departments (i.e., positioned along the sea shore of France) on the pace of this diffusion process.



**Figure 2:** Geographic characteristics of French departments

Finally, the research accounts for the potential differential effects of international trade on process of development as well as on the adoption the steam engine. In particular, it captures by the potential effect of maritime departments (i.e., those departments that are positioned along the sea shore of France), via trade, on the diffusion of the steam engine and thus economic development as well as its direct effect on the evolution of income per capita over this time period.

### 2.3.2 Institutional Characteristics

The analysis deals with the effect of variations in the adoption of the steam engine across French departments on their comparative development. This empirical strategy ensures that institutional factors that were unique to France as a whole over this time period are not the source of the differential pattern of development across these regions. Nevertheless, two regions of France over this time period had a unique exposure to institutional characteristics that may have contributed to the observed relationship between industrialization and economic development.

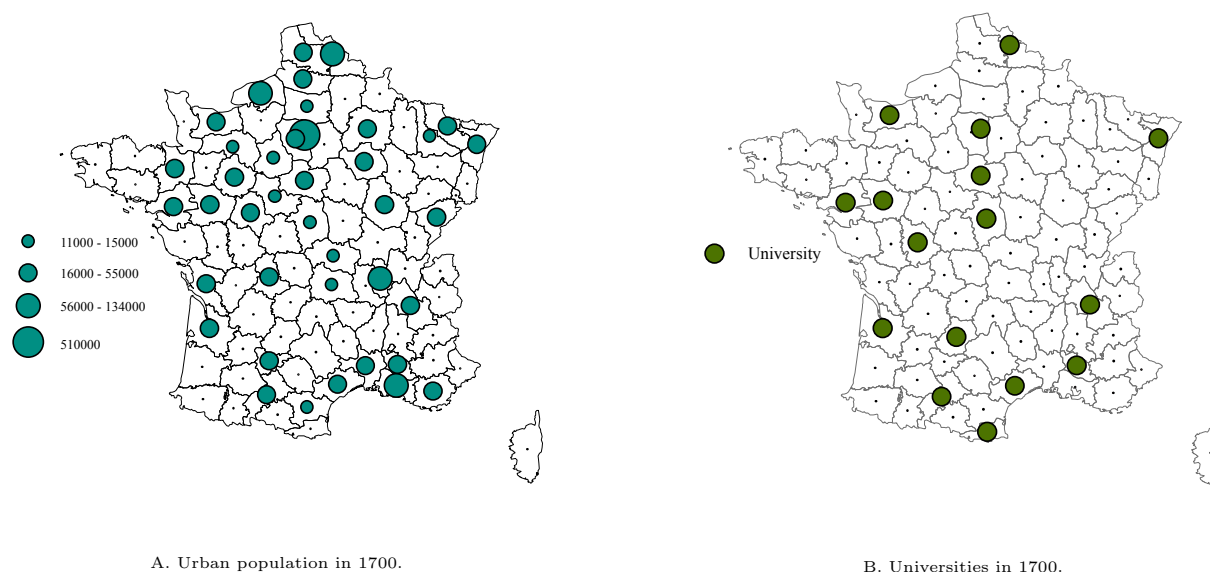
First, the emergence of state centralization in France, centuries prior to the process of industrialization, and the concentration of political power in Paris, may have affected differentially the political culture and economic prosperity in Paris and its suburbs (i.e., Seine, Seine-et-Marne and Seine-et-Oise). Hence, the empirical analysis includes a dummy variable for these three departments, accounting for their potential confounding effects on the observed relationship between industrialization and economic development, in general, and the adoption of the steam engine, in particular. Moreover, the analysis captures the potential decline in the grip of the central government in regions at a greater distance from Paris, and the diminished potential diffusion of develop-



ment into these regions, accounting for the effect of the aerial distance between the administrative center of each department and Paris.

Second, the relationship between industrialization and development in the Alsace-Lorraine region (i.e., the Bas-Rhin, Haut-Rhin and the Moselle departments) that was under German domination in the 1871-1918 period may represent the persistence of institutional and economic characteristics that reflected their unique experience.<sup>5</sup> Hence, the empirical analysis includes a dummy variable to account for the confounding effects of the characteristics of the three departments in the Alsace-Lorraine region.

### 2.3.3 Pre-Industrial Development



**Figure 3:** Urban population and universities in 1700

The differential level of development across France in the pre-industrial era may have affected jointly the process of development and the process of industrialization. In particular, it may have affected the adoption of the steam engine and it may have generated, independently, a persistent effect on the process of development. Hence, the empirical analysis accounts for the potentially confounding effects of the level of development in the pre-industrial period, more than 150 years prior to the 1860-1865 industrial survey. This early level of development is captured by the degree of urbanization (i.e., population of urban centers with more than 10,000 inhabitants) in each French department in 1700 (Lepetit, 1994) and the number of universities in 1700 (Bosker et al., 2013)

<sup>5</sup>Differences in the welfare laws and labor market regulations in Alsace-Lorraine and the rest of France persisted throughout most of the 20<sup>th</sup> century (see, e.g., Chemin and Wasmer, 2009). In particular, the differences in the laws governing the separation of Church and State in this region may have had a different effect on the evolution of fertility.

which are mapped in Figure 3.<sup>6</sup>

### 2.3.4 Pre-Industrial Fertility

Variations in fertility rates across France in the pre-industrial era may have affected the subsequent levels of fertility in each region, and in particular, the differential decline in fertility rates in the course of the demographic transition. Hence the empirical analysis accounts for the potential confounding effects of the level of fertility in 1811, 50 years prior to the 1860-1865 industrial survey.<sup>7</sup>

## 3 Empirical Methodology

### 3.1 Empirical Strategy

The observed relationship between industrialization and fertility is not necessarily a causal one. It may reflect the impact of economic development on the process of industrialization as well as the influence of institutional, geographical, cultural and human capital characteristics on the joint process of industrialization and fertility decline. In light of the endogeneity of industrialization and fertility, this research exploits exogenous regional variations in the adoption of the steam engine across France to establish the causal effect of industrialization on fertility.

The identification strategy is motivated by the historical account of the gradual regional diffusion of the steam engine in France during the 18<sup>th</sup> and 19<sup>th</sup> century (Ballot, 1923; Sée, 1925; Léon, 1976).<sup>8</sup> Considering the positive association between industrialization and the use of the steam engine (Mokyr, 1990; Bresnahan and Trajtenberg, 1995; Rosenberg and Trajtenberg, 2004), the study takes advantage of the regional diffusion of the steam engine to identify the impact of local variations in the intensity of the use of the steam engine during the 1860-1865 period on the process of development. In particular, it exploits the distances between each French department and Fresnes-sur-Escaut (in the Nord department), where the first commercial application of the steam engine across France was made in 1732, as an instrument for the use of the steam engines in 1860-1865.<sup>9</sup>

Consistent with the diffusion hypothesis, the second steam engine in France that was utilized for commercial purposes was operated in 1737 in the mines of Anzin, also in the Nord department,

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<sup>6</sup>The qualitative analysis remains intact if the potential effect of past population density is accounted for.

<sup>7</sup>There is no data on fertility at the department level before 1806 (Bonneuil, 1997)

<sup>8</sup>There was also a regional pattern in the diffusion of steam engines in England (Kanefsky and Robey, 1980; Nuvolari et al., 2011) and in the USA (Atack, 1979).

<sup>9</sup>This steam engine was used to pump water in an ordinary mine of Fresnes-sur-Escaut. It is unclear whether Pierre Mathieu, the owner of the mine, built the engine himself after a trip in England or employed an Englishman for this purpose (Ballot, 1923, p.385).

**Table 1:** The geographical diffusion of the steam engine

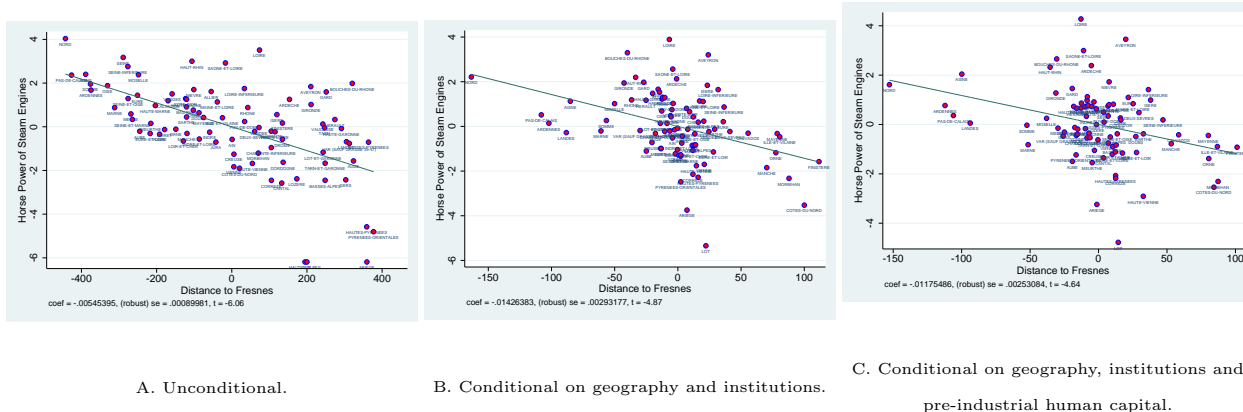
|                          | (1)<br>OLS                   | (2)<br>OLS             | (3)<br>OLS             | (4)<br>OLS             | (5)<br>OLS             |
|--------------------------|------------------------------|------------------------|------------------------|------------------------|------------------------|
|                          | Horse Power of Steam Engines |                        |                        |                        |                        |
| Distance to Fresnes      | -0.0055***<br>[0.0009]       | -0.0084***<br>[0.0023] | -0.0143***<br>[0.0029] | -0.0073***<br>[0.0019] | -0.0118***<br>[0.0025] |
| Average Altitude         |                              | 0.349<br>[0.432]       | 0.447<br>[0.475]       | 0.555<br>[0.390]       | 0.542<br>[0.414]       |
| Average Rainfall         |                              | 2.100<br>[1.368]       | 1.234<br>[1.441]       | 3.301***<br>[1.244]    | 2.517*<br>[1.391]      |
| Average Temperature      |                              | 7.695***<br>[2.055]    | 8.438***<br>[2.150]    | 8.021***<br>[2.004]    | 8.480***<br>[2.023]    |
| Latitude                 |                              | 0.535<br>[11.33]       | -2.411<br>[11.77]      | 6.475<br>[9.840]       | 4.358<br>[10.50]       |
| Land Suitability         |                              | -1.061<br>[0.848]      | -1.448<br>[0.900]      | -1.253<br>[0.798]      | -1.499*<br>[0.814]     |
| Maritime Department      |                              |                        | 0.345<br>[0.472]       |                        | 0.0940<br>[0.366]      |
| Distance to Paris        |                              |                        | 0.0066**<br>[0.0026]   |                        | 0.0052*<br>[0.0026]    |
| Paris and Suburbs        |                              |                        | 0.669<br>[0.773]       |                        | 0.477<br>[0.448]       |
| University               |                              |                        |                        | -0.118<br>[0.518]      | -0.133<br>[0.511]      |
| Urban Population in 1700 |                              |                        |                        | 0.381***<br>[0.114]    | 0.335***<br>[0.112]    |
| Adjusted R2              | 0.331                        | 0.420                  | 0.444                  | 0.490                  | 0.491                  |
| Observations             | 85                           | 85                     | 85                     | 85                     | 85                     |

Note: The dependent variable and the explanatory variables except the dummies are in logarithm. The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

less than 10 km away from Fresnes-sur-Escaut. Furthermore, in the subsequent decades till the 1789 French Revolution the commercial use of the steam engine expanded predominantly to the nearby northern and north-western regions. However, at the onset of the French revolution in 1789, steam engines were less widespread in France than in England. A few additional steam engines were introduced until the fall of the Napoleonic Empire in 1815, notably in Saint-Quentin in 1803 and in Mulhouse in 1812, but it is only after 1815 that the diffusion of steam engines in France accelerated (Sée, 1925; Léon, 1976).

However, in light of the confounding effects of geographic, institutional and demographic characteristics on the pace of technological diffusion, as well as on the process of development, in order to mitigate the potential effect of unobserved heterogeneity, the econometric model accounts for a wide range of these characteristics (altitude, latitude, rainfall, land suitability, maritime and border departments, Paris and its suburbs, the distance to Paris).

Indeed, in line with the historical account, the distribution of steam engines across French departments in 1860-1865 is indicative of a local diffusion process from Fresnes-sur-Escaut. As reported in Column 1 of Table 1 and shown in Panel A of Figure 4, there is a highly significant negative correlation between the distance from Fresnes-sur-Escaut to the administrative center of each department and the number of steam engines in the department. But as discussed above, pre-industrial development and a wide range of confounding geographical and institutional char-



**Figure 4:** The effect of the distance from Fresnes-sur-Escout on the horse power of steam engines in 1839-1847  
 Note: These figures depict the partial regression line for the effect of the distance from Fresnes-sur-Escout on the number of steam engines in each French department in 1839-1847. Panel A presents the unconditional relationship, Panel B reports the relationship which controls for geographic and institutional characteristics, and Panel C also controls for pre-industrial development. Thus, the x- and y-axes in Panels A, B and C plot the residuals obtained from regressing steam engine intensity and the distance from Fresnes-sur-Escout, respectively with and without the aforementioned set of covariates.

acteristics could have contributed to the adoption of the steam engine. Reassuringly, the unconditional negative relationship between the distance to Fresnes-sur-Escout and the number of steam engines remains highly significant and is of the same magnitude when exogenous confounding geographical controls i.e., altitude, land suitability, latitude, rainfall and temperature (Column 2) and institutional factors (Column 3) are accounted for. Importantly, there is still a highly significant negative correlation between the distance from Fresnes-sur-Escout to the administrative center of each department and the intensity of the use of steam engines in the department when all these control variables are included in the same regression (Column 3 of Table 1 and Panel B of Figure 4). Specifically, a 100-km increase in the distance from Fresnes-sur-Escout is associated with a 1.43 point decrease in the log of the horse power of steam engines in a given department. This means that, if the distance of a department away from Fresnes-sur-Escout was to increase from the 25th percentile (326.7 km) to 75th percentile (658.6 km) of the distance distribution, this department would experience a 4.75 point drop in the log of the horse power of steam engines (i.e., relative to a sample mean of 2.69 and a standard deviation of 3.59). Finally, our findings suggest that pre-industrial economic development, which is captured by the degree of urbanization in 1700 had a persistent positive and significant association with the adoption of the steam engine. In addition, pre-industrial human development, as captured by the number of universities in 1700, had an insignificant association with the adoption of the steam engine (Columns (4)-(5) of Table 1 and Panel C of Figure 4).

Moreover, the highly significant negative correlation between the horse power of steam engines in each department and the distance from Fresnes-sur-Escout to the administrative center of each

department is robust to the inclusion of an additional set of confounding geographical, demographic and institutional characteristics, as well as to the forces of pre-industrial development, which as discussed in section 5, may have contributed to the relationship between industrialization and economic development. As established in Table B.1 in Appendix B, these confounding factors, which could be largely viewed as endogenous to the adoption of the steam engine and are thus not part of the baseline analysis, do not affect the qualitative results.

### 3.2 Empirical Model

The effect of industrialization on the process of development is estimated using 2SLS. The second stage provides a cross-section estimate of the relationship between the total horse power of steam engines in each department in 1860-1865 and fertility at different points in time;

$$F_{it} = \alpha + \beta E_i + \mathbf{X}'_i \omega + \varepsilon_{it}, \quad (1)$$

where  $F_{it}$  represents fertility in department  $i$  in year  $t$ ,  $E_i$  is the log of total horse power of steam engines in department  $i$  in 1860-1865,  $\mathbf{X}'_i$  is a vector of geographical, institutional and pre-industrial economic characteristics of department  $i$  and  $\varepsilon_{it}$  is an i.i.d. error term for department  $i$  in year  $t$ .

In the first stage,  $E_i$ , the log of total horse power of steam engines in department  $i$  in 1860-1865 is instrumented by  $D_i$ , the aerial distance (in kilometers) between the administrative center of department  $i$  and Fresnes-sur-Escaut;

$$E_i = \delta_1 D_i + \mathbf{X}'_i \delta_2 + \mu_i, \quad (2)$$

where  $\mathbf{X}'_i$  is the same vector of geographical, institutional and pre-industrial economic characteristics of department  $i$  used in the second stage, and  $\mu_i$  is an error term for department  $i$ .

## 4 Industrialization and the Onset of the Fertility Transition

### 4.1 Potential Mechanisms

The effect of industrialization on fertility is plausibly operated through four possible channels: the rise in income per capita, the rise in human capital formation, the decline in child mortality and the decline in the gender wage gap.

**The Income Channel.** As established in the IV regressions in Table 2, the intensity of the use of the steam engine in 1860-1865 has had a persistent positive impact on GDP per capita in the subsequent decades. In particular it had a positive and significant effect on income per capita in the years 1872, 1886, 1911 and 1930. The rise in household income generated two conflicting effects on

**Table 2:** Industrialization and the evolution of income per capita in the 1871–1931 period

|  | (1)                  | (2)                   | (3)                  | (4)                   | (5)                     | (6)                     | (7)                     | (8)                     |
|--|----------------------|-----------------------|----------------------|-----------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|  | OLS                  | OLS                   | OLS                  | OLS                   | IV                      | IV                      | IV                      | IV                      |
|  | 1872                 | 1886                  | 1911                 | GDP per capita        |                         | 1886                    | 1911                    | 1930                    |
|  |                      |                       |                      | 1872                  | 1886                    |                         |                         |                         |
| Horse Power of Steam Engines   | 0.0394**<br>[0.0162] | 0.0385*<br>[0.0207]   | 0.0340<br>[0.0209]   | 0.0705***<br>[0.0106] | 0.110***<br>[0.0413]    | 0.126***<br>[0.0467]    | 0.173***<br>[0.0502]    | 0.151***<br>[0.0253]    |
| Average Altitude   | -0.136*<br>[0.0726]  | -0.273***<br>[0.0927] | -0.0493<br>[0.105]   | -0.0261<br>[0.0476]   | -0.189**<br>[0.0733]    | -0.338***<br>[0.102]    | -0.153<br>[0.114]       | -0.0860*<br>[0.0501]    |
| Average Rainfall   | -0.277<br>[0.230]    | -0.0510<br>[0.271]    | -0.353<br>[0.252]    | -0.275**<br>[0.114]   | -0.356<br>[0.231]       | -0.149<br>[0.280]       | -0.509<br>[0.326]       | -0.376**<br>[0.170]     |
| Average Temperature  | -0.578<br>[0.410]    | -1.231**<br>[0.490]   | -1.193***<br>[0.428] | -0.647***<br>[0.186]  | -1.052**<br>[0.452]     | -1.817***<br>[0.561]    | -2.121***<br>[0.563]    | -1.185***<br>[0.248]    |
| Average Latitude   | -5.284<br>[3.253]    | -2.928<br>[3.508]     | -1.795<br>[3.508]    | -2.299<br>[1.438]     | -7.413**<br>[2.918]     | -5.558*<br>[3.159]      | -5.957*<br>[3.296]      | -4.583***<br>[1.340]    |
| Average Land Suitability   | 0.271*<br>[0.147]    | 0.326*<br>[0.173]     | 0.576***<br>[0.156]  | 0.317***<br>[0.0481]  | 0.293**<br>[0.139]      | 0.354**<br>[0.174]      | 0.620***<br>[0.189]     | 0.346***<br>[0.0757]    |
| Maritime Department  | 0.091<br>[0.0968]    | -0.028<br>[0.113]     | 0.079<br>[0.112]     | 0.009<br>[0.0548]     | 0.052<br>[0.105]        | -0.075<br>[0.114]       | 0.004<br>[0.124]        | -0.038<br>[0.0733]      |
| Distance to Paris  | -0.0011<br>[0.0007]  | 0.0001<br>[0.0008]    | -0.0002<br>[0.0007]  | -0.00003<br>[0.0003]  | -0.0010<br>[0.0007]     | 0.0003<br>[0.0007]      | 0.0001<br>[0.0007]      | 0.0002<br>[0.0003]      |
| Paris and Suburbs  | 0.0395<br>[0.0977]   | 0.197<br>[0.173]      | 0.105<br>[0.130]     | 0.282*<br>[0.147]     | 0.00922<br>[0.110]      | 0.159<br>[0.181]        | 0.0458<br>[0.188]       | 0.250***<br>[0.0946]    |
| Alsace-Lorraine  |                      |                       |                      | 0.198**<br>[0.0756]   |                         |                         |                         | 0.0766<br>[0.118]       |
| Adjusted R2  | 0.359                | 0.150                 | 0.251                | 0.551                 |                         |                         |                         |                         |
| Observations   | 82                   | 82                    | 82                   | 84                    | 82                      | 82                      | 82                      | 84                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                      |                       |                      |                       |                         |                         |                         |                         |
| Distance to Fresnes  |                      |                       |                      |                       | -0.0136***<br>[0.00282] | -0.0136***<br>[0.00282] | -0.0136***<br>[0.00282] | -0.0138***<br>[0.00283] |
| F-stat (1 <sup>st</sup> stage)   |                      |                       |                      |                       | 23.371                  | 23.371                  | 23.371                  | 23.760                  |

Note: The post-WWI regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

fertility rates. On the one hand, the income effect operated towards an increase in fertility, but on the other hand, the substitution effect, due to the rise in the opportunity cost of raising children, operated towards a reduction in the number of children. As suggested by economic theory, under a broad class of preferences, the income effect and the substitution effect are likely to cancel one another. As established in Tables B.12 to B.15 in Appendix B, in the years 1871, 1891, 1911 and 1931, the rise in income per capita had an insignificant relationship with fertility rates, suggesting that the income and substitution effects offset each other over this period, in line with insights from fertility theory (Galor, 2012). Thus it appears that the effect of industrialization on income has no role in the differential patterns of the fertility decline across French departments.

**The Human Capital Channel.** As established in the IV regressions in Tables 3-4, industrialization generated a demand for human capital and stimulated human capital formation over the 1871-1931 period. In particular, as established in Table 3, industrialization had a positive and significant effects on the share of literate conscripts in 1872 and 1892 (as long as school attendance was not compulsory for the men in those cohorts).<sup>10</sup> Moreover, as established in Table 4, industrialization had a positive and significant effect on the share of high-school graduates among

<sup>10</sup>Conscripts were 20-year old men who attended school approximately a decade before they reported for military service. Hence, it is likely that the cohort of conscripts in 1892 was not affected by the adoption of the 1881-1882 laws on free and compulsory education until age 13.

**Table 3:** Industrialization and the evolution of literacy among French army conscripts in the 1871–1931 period

|  | (1)                    | (2)                   | (3)                    | (4)                          | (5)                    | (6)                    | (7)                    | (8)                    |
|--|------------------------|-----------------------|------------------------|------------------------------|------------------------|------------------------|------------------------|------------------------|
|  | OLS                    | OLS                   | OLS                    | OLS                          | IV                     | IV                     | IV                     | IV                     |
|  | 1872                   | 1892                  | 1911                   | Share of literate conscripts |                        | 1872                   | 1911                   | 1931                   |
| Horse Power of Steam Engines   | 0.0158**<br>[0.0068]   | 0.0113***<br>[0.0031] | 0.0040**<br>[0.0016]   | 0.0027<br>[0.0018]           | 0.0477**<br>[0.0197]   | 0.0163**<br>[0.0076]   | -0.0013<br>[0.0037]    | 0.0064<br>[0.0046]     |
| Average Altitude   | -0.0767***<br>[0.0258] | -0.0230*<br>[0.0136]  | -0.0043<br>[0.0060]    | -0.0059<br>[0.0078]          | -0.100***<br>[0.0302]  | -0.0270*<br>[0.0139]   | -0.0002<br>[0.0071]    | -0.0087<br>[0.0086]    |
| Average Rainfall   | 0.0856<br>[0.0780]     | -0.0039<br>[0.0410]   | -0.0056<br>[0.0260]    | 0.0215<br>[0.0208]           | 0.0500<br>[0.0880]     | -0.0105<br>[0.0399]    | 0.0013<br>[0.0254]     | 0.0167<br>[0.0196]     |
| Average Temperature  | -0.785***<br>[0.147]   | -0.350***<br>[0.0697] | -0.0859***<br>[0.0316] | -0.0490<br>[0.0410]          | -0.997***<br>[0.175]   | -0.386***<br>[0.0825]  | -0.0487<br>[0.0426]    | -0.0742<br>[0.0512]    |
| Average Latitude   | -2.395**<br>[1.041]    | -1.080***<br>[0.345]  | -0.390**<br>[0.149]    | -0.0076<br>[0.180]           | -3.351***<br>[0.963]   | -1.260***<br>[0.380]   | -0.2040<br>[0.204]     | -0.1150<br>[0.233]     |
| Average Land Suitability   | 0.260***<br>[0.0565]   | 0.138***<br>[0.0207]  | 0.0266***<br>[0.00906] | 0.0013<br>[0.00972]          | 0.270***<br>[0.0571]   | 0.140***<br>[0.0204]   | 0.0242**<br>[0.0101]   | 0.0027<br>[0.0103]     |
| Maritime Department  | -0.0055<br>[0.0306]    | -0.0229*<br>[0.0124]  | -0.0111<br>[0.00713]   | -0.0057<br>[0.0107]          | -0.0227<br>[0.0361]    | -0.0249**<br>[0.0126]  | -0.0090<br>[0.00718]   | -0.0079<br>[0.0105]    |
| Distance to Paris  | -0.0003<br>[0.00025]   | -0.0001<br>[8.99e-05] | -0.00003<br>[4.31e-05] | 0.00003<br>[5.11e-05]        | -0.0002<br>[0.000249]  | -0.0001<br>[8.55e-05]  | -0.00003<br>[4.35e-05] | 0.00004<br>[5.21e-05]  |
| Paris and Suburbs  | 0.0303<br>[0.0517]     | 0.0359**<br>[0.0170]  | 0.0136<br>[0.0082]     | 0.0059<br>[0.0129]           | 0.0167<br>[0.0482]     | 0.0330*<br>[0.0188]    | 0.0166*<br>[0.00957]   | 0.0044<br>[0.0137]     |
| Alsace-Lorraine  |                        |                       |                        | -0.0122<br>[0.0091]          |                        |                        |                        | -0.0178*<br>[0.0103]   |
| Adjusted R2  | 0.283                  | 0.462                 | 0.170                  | -0.044                       |                        |                        |                        |                        |
| Observations   | 82                     | 83                    | 83                     | 85                           | 82                     | 83                     | 83                     | 85                     |
| First stage: the instrumented variable is Horse Power of Steam Engines |                        |                       |                        |                              |                        |                        |                        |                        |
| Distance to Fresnes  |                        |                       |                        |                              | -0.0136***<br>[0.0028] | -0.0142***<br>[0.0030] | -0.0142***<br>[0.0030] | -0.0138***<br>[0.0028] |
| F-stat (1 <sup>st</sup> stage)   |                        |                       |                        |                              | 23.371                 | 22.549                 | 22.549                 | 24.042                 |

Note: The post-WWI regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

conscripts between 1892 and 1931. In addition, as established in Table 5, industrialization had a positive and significant effect on life expectancy in 1871 and 1891 but not in 1911. The rise in the industrial demand for human capital, reinforced by the rise in life expectancy, induced households to invest in the human capital of their children and thus in the presence of a budget constraint, it operated towards a reduction in fertility. Indeed, as established in Tables B.12 to B.15 in Appendix B, in the years 1871, 1891, 1911 and 1931, the rise in human capital formation had a negative and mostly significant relationship with fertility rates, diminishing the direct effect of industrialization, and suggesting therefore that the effect of industrialization on human capital formation was an instrumental force in the differential pattern of the fertility decline across French departments.

**The Mortality Channel.** As established in the IV regressions in Table 6, industrialization diminished child mortality rates in 1871 and 1891, but had no effect on mortality thereafter.<sup>11</sup> Furthermore, as established in Tables B.12 to B.15 in Appendix B, child mortality rates are positively associated with fertility rates over the 1871-1931 period. Thus, the effect of industrialization on the decline in child mortality appears to contribute to the decline in fertility in 1871 and 1891, but not in 1911.

**The Gender Wage Gap Channel.** Industrialization could have triggered a decline in the

<sup>11</sup>Mortality rates across departments in 1931 are not available.

**Table 4:** Industrialization and the share of high-school graduates among French army conscripts in the 1871–1931 period

|  | (1)   | (2)                     | (3)                    | (4)                      | (5)                     | (6)                     | (7)                     | (8)                       |
|--|---|-------------------------|------------------------|--------------------------|-------------------------|-------------------------|-------------------------|---------------------------|
|  | OLS   | OLS                     | OLS                    | OLS                      | IV                      | IV                      | IV                      | IV                        |
|  | Share of high-school graduates among conscripts |                         |                        |                          |                         |                         |                         |                           |
|  | 1872  | 1892                    | 1911                   | 1931                     | 1872                    | 1892                    | 1911                    | 1931                      |
| Horse Power of Steam Engines   | -0.0001<br>[0.0002]                             | 0.0007<br>[0.0006]      | 0.0003<br>[0.0007]     | 0.0014***<br>[0.0005]    | 0.0006<br>[0.0008]      | 0.0029**<br>[0.001]     | 0.0022**<br>[0.001]     | 0.0068***<br>[0.0018]     |
| Average Altitude   | -0.0009<br>[0.00129]                            | -0.0017<br>[0.00234]    | -0.0040<br>[0.00299]   | -0.0027<br>[0.00279]     | -0.0015<br>[0.00129]    | -0.0033<br>[0.00244]    | -0.00540**<br>[0.00274] | -0.00678*<br>[0.00395]    |
| Average Rainfall   | 0.0028<br>[0.00343]                             | -0.0011<br>[0.00566]    | 0.0097<br>[0.00995]    | 0.0096<br>[0.00683]      | 0.0019<br>[0.00372]     | -0.0035<br>[0.00636]    | 0.0075<br>[0.0106]      | 0.0027<br>[0.0100]        |
| Average Temperature  | -0.0144*<br>[0.00775]                           | -0.0202**<br>[0.00881]  | -0.0145<br>[0.0135]    | -0.0318**<br>[0.0141]    | -0.0196**<br>[0.0085]   | -0.0345***<br>[0.0114]  | -0.0276**<br>[0.0140]   | -0.0682***<br>[0.0184]    |
| Average Latitude   | -0.0596<br>[0.0414]                             | -0.0892<br>[0.0823]     | -0.0571<br>[0.0656]    | -0.0267<br>[0.0909]      | -0.0829**<br>[0.0343]   | -0.154**<br>[0.0732]    | -0.116*<br>[0.0608]     | -0.181*<br>[0.105]        |
| Average Land Suitability   | 0.00411**<br>[0.00171]                          | 0.0102***<br>[0.00355]  | 0.0110***<br>[0.00284] | 0.0155**<br>[0.00594]    | 0.00435***<br>[0.00168] | 0.0109***<br>[0.00412]  | 0.0117***<br>[0.00312]  | 0.0175**<br>[0.00750]     |
| Maritime Department  | 0.00413*<br>[0.00209]                           | -0.0003<br>[0.00276]    | -0.0041<br>[0.00262]   | -0.0018<br>[0.00256]     | 0.00371*<br>[0.00207]   | -0.0014<br>[0.00306]    | -0.00510**<br>[0.00244] | -0.0050<br>[0.00356]      |
| Distance to Paris  | -0.00001<br>[8.43e-06]                          | -0.000003<br>[1.76e-05] | 0.00002<br>[1.57e-05]  | 4.69e-05**<br>[1.87e-05] | -0.000006<br>[8.70e-06] | 0.000002<br>[1.90e-05]  | 0.00002<br>[1.63e-05]   | 6.15e-05***<br>[2.27e-05] |
| Paris and Suburbs  | 0.00002<br>[0.000840]                           | 0.0137*<br>[0.00786]    | 0.0192***<br>[0.00565] | 0.0323***<br>[0.00970]   | -0.0003<br>[0.00104]    | 0.0128**<br>[0.00603]   | 0.0183***<br>[0.00416]  | 0.0302***<br>[0.00736]    |
| Alsace-Lorraine  |   |                         |                        | 0.0166*<br>[0.00875]     |                         |                         |                         | 0.0085<br>[0.0112]        |
| Adjusted R2  | 0.111   | 0.121                   | 0.189                  | 0.459                    |                         |                         |                         |                           |
| Observations   | 82  | 82                      | 82                     | 85                       | 82                      | 82                      | 82                      | 85                        |
| First stage: the instrumented variable is Horse Power of Steam Engines |   |                         |                        |                          |                         |                         |                         |                           |
| Distance to Fresnes  |   |                         |                        |                          | -0.0136***<br>[0.00282] | -0.0136***<br>[0.00282] | -0.0136***<br>[0.00282] | -0.0138***<br>[0.00280]   |
| F-stat (1 <sup>st</sup> stage)   |   |                         |                        |                          | 23.371                  | 23.371                  | 23.371                  | 24.042                    |

Note: The post-WWI regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table 5:** Industrialization and life expectancy at age 15 in the 1871–1911 period

|  | (1)                       | (2)                    | (3)                  | (4)                    | (5)                    | (6)                    |
|--|---------------------------|------------------------|----------------------|------------------------|------------------------|------------------------|
|  | OLS                       | OLS                    | OLS                  | IV                     | IV                     | IV                     |
|  | Life Expectancy at Age 15 |                        |                      |                        |                        |                        |
|  | 1871                      | 1891                   | 1911                 | 1871                   | 1891                   | 1911                   |
| Horse Power of Steam Engines   | -0.0158<br>[0.162]        | -0.0491<br>[0.103]     | 0.0729<br>[0.0825]   | 1.216***<br>[0.455]    | 0.885***<br>[0.286]    | 0.327<br>[0.288]       |
| Average Altitude   | 0.7300<br>[0.881]         | -0.5440<br>[0.441]     | -0.5440<br>[0.347]   | -0.1860<br>[0.786]     | -1.238**<br>[0.573]    | -0.733**<br>[0.352]    |
| Average Rainfall   | -2.553<br>[2.273]         | 2.298<br>[1.638]       | 0.957<br>[0.738]     | -3.932<br>[2.881]      | 1.253<br>[2.338]       | 0.672<br>[0.931]       |
| Average Temperature  | 3.871<br>[4.233]          | 3.619<br>[2.476]       | -0.096<br>[1.721]    | -4.352<br>[3.976]      | -2.617<br>[2.816]      | -1.793<br>[2.242]      |
| Average Latitude   | 21.2500<br>[49.62]        | -48.53***<br>[14.91]   | -63.45*<br>[35.76]   | -15.67<br>[39.90]      | -76.52***<br>[16.14]   | -71.07**<br>[28.48]    |
| Average Land Suitability   | 1.956<br>[1.387]          | 0.404<br>[0.792]       | -0.555<br>[0.478]    | 2.346<br>[1.515]       | 0.700<br>[1.014]       | -0.474<br>[0.571]      |
| Maritime Department  | -1.627<br>[1.312]         | -0.580<br>[0.544]      | 0.605<br>[0.891]     | -2.292<br>[1.481]      | -1.084<br>[0.753]      | 0.467<br>[0.950]       |
| Distance to Paris  | 0.0009<br>[0.0105]        | -0.0152***<br>[0.0036] | -0.0140*<br>[0.0075] | 0.0037<br>[0.0110]     | -0.0132***<br>[0.0042] | -0.0135*<br>[0.0075]   |
| Paris and Suburbs  | -2.987*<br>[1.500]        | -5.235***<br>[0.663]   | -3.164***<br>[0.696] | -3.512*<br>[1.991]     | -5.633***<br>[1.181]   | -3.272***<br>[0.681]   |
| Adjusted R2  | 0.074                     | 0.415                  | 0.160                |                        |                        |                        |
| Observations   | 82                        | 82                     | 82                   | 82                     | 82                     | 82                     |
| First stage: the instrumented variable is Horse Power of Steam Engines |                           |                        |                      |                        |                        |                        |
| Distance to Fresnes  |                           |                        |                      | -0.0136***<br>[0.0028] | -0.0136***<br>[0.0028] | -0.0136***<br>[0.0028] |
| F-stat (1 <sup>st</sup> stage)   |                           |                        |                      | 23.371                 | 23.371                 | 23.371                 |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.



**Table 6:** Industrialization and child mortality (age 0-1) in the 1871–1911 period

|  | (1)               | (2)      | (3)        | (4)        | (5)        | (6)        |
|--|-------------------|----------|------------|------------|------------|------------|
|  | OLS               | OLS      | OLS        | IV         | IV         | IV         |
|  | Mortality Age 0-1 |          |            |            |            |            |
|  | 1871              | 1891     | 1911       | 1871       | 1891       | 1911       |
| Horse Power of Steam Engines   | -0.003            | 0.001    | 0.001      | -0.0383*** | -0.0310*** | 0.001      |
|  | [0.0048]          | [0.0033] | [0.0009]   | [0.0125]   | [0.010]    | [0.001]    |
| Average Altitude   | -0.019            | -0.006   | 0.002      | 0.011      | 0.021      | 0.002      |
|  | [0.0264]          | [0.0168] | [0.0024]   | [0.0235]   | [0.0205]   | [0.0023]   |
| Average Rainfall   | 0.102             | -0.027   | -0.0248*** | 0.138      | 0.005      | -0.0243*** |
|  | [0.0666]          | [0.0487] | [0.00704]  | [0.0875]   | [0.0757]   | [0.00683]  |
| Average Temperature  | -0.148            | -0.211** | -0.0577*** | 0.105      | 0.018      | -0.0550*** |
|  | [0.131]           | [0.0965] | [0.0114]   | [0.113]    | [0.0999]   | [0.0108]   |
| Average Latitude   | -0.269            | 0.403    | 0.074      | 1.008      | 1.557**    | 0.086      |
|  | [1.076]           | [0.894]  | [0.0655]   | [0.768]    | [0.711]    | [0.0581]   |
| Average Land Suitability   | -0.031            | 0.020    | 0.0133***  | -0.046     | 0.006      | 0.0132***  |
|  | [0.0404]          | [0.0323] | [0.0038]   | [0.0438]   | [0.0365]   | [0.0035]   |
| Maritime Department  | 0.0499*           | 0.0367*  | 0.00630*   | 0.0649**   | 0.0503*    | 0.00652*   |
|  | [0.0273]          | [0.0209] | [0.00375]  | [0.0318]   | [0.0273]   | [0.0038]   |
| Distance to Paris  | 0.00002           | 0.0002   | 4.62e-05** | -0.00002   | 0.0002     | 4.53e-05** |
|  | [0.0002]          | [0.0002] | [1.81e-05] | [0.0002]   | [0.0002]   | [1.79e-05] |
| Paris and Suburbs  | 0.042             | 0.0861** | 0.0124**   | 0.061      | 0.103*     | 0.0126***  |
|  | [0.0478]          | [0.0347] | [0.00494]  | [0.0691]   | [0.0534]   | [0.00473]  |
| Adjusted R2  | 0.156             | 0.272    | 0.353      |            |            |            |
| Observations   | 82                | 82       | 82         | 82         | 82         | 82         |
| First stage: the instrumented variable is Horse Power of Steam Engines |                   |          |            |            |            |            |
| Distance to Fresnes  |                   |          |            | -0.0140*** | -0.0140*** | -0.0136*** |
|  |                   |          |            | [0.0029]   | [0.0029]   | [0.0028]   |
| F-stat (1 <sup>st</sup> stage)   |                   |          |            | 24.018     | 24.018     | 23.371     |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table 7:** Industrialization and the male–female wage ratio in the 1891–1911 period

|  | (1)                    | (2)      | (3)        | (4)        |
|--|------------------------|----------|------------|------------|
|  | OLS                    | OLS      | IV         | IV         |
|  | Male-Female Wage Ratio |          |            |            |
|  | 1891                   | 1911     | 1891       | 1911       |
| Horse Power of Steam Engines   | -0.011                 | -0.010   | 0.008      | 0.014      |
|  | [0.0148]               | [0.0116] | [0.0348]   | [0.0292]   |
| Average Altitude   | -0.009                 | 0.009    | -0.023     | -0.009     |
|  | [0.0780]               | [0.0513] | [0.0767]   | [0.0488]   |
| Average Rainfall   | 0.163                  | -0.203   | 0.141      | -0.242     |
|  | [0.250]                | [0.153]  | [0.235]    | [0.169]    |
| Average Temperature  | 0.458                  | 0.255    | 0.327      | 0.086      |
|  | [0.411]                | [0.289]  | [0.392]    | [0.303]    |
| Average Latitude   | 2.306                  | -1.491   | 1.717      | -2.191     |
|  | [1.825]                | [1.542]  | [1.918]    | [1.477]    |
| Average Land Suitability   | -0.042                 | -0.173** | -0.036     | -0.163**   |
|  | [0.153]                | [0.0847] | [0.141]    | [0.0764]   |
| Maritime Department  | -0.026                 | 0.054    | -0.036     | 0.041      |
|  | [0.0854]               | [0.0696] | [0.0753]   | [0.0730]   |
| Distance to Paris  | 0.0009**               | -0.001   | 0.001**    | -0.001     |
|  | [0.0004]               | [0.0004] | [0.0004]   | [0.0004]   |
| Paris and Suburbs  | 0.578**                | -0.229** | 0.570***   | -0.239**   |
|  | [0.224]                | [0.101]  | [0.220]    | [0.0950]   |
| Adjusted R2  | 0.176                  | 0.040    |            |            |
| Observations   | 82                     | 78       | 82         | 78         |
| First stage: the instrumented variable is Horse Power of Steam Engines |                        |          |            |            |
| Distance to Fresnes  |                        |          | -0.0136*** | -0.0136*** |
|  |                        |          | [0.00282]  | [0.00287]  |
| F-stat (1 <sup>st</sup> stage)   |                        |          | 23.371     | 22.366     |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

gender wage gap (Galor and Weil, 1996), and consequently, a decline in fertility. However, as established in Table 7, industrialization is not associated with the decline in the gender wage gap in 1891 and 1911. Consequently the decline in fertility cannot be attributed to this channel over this time period.

## 4.2 The effect of Industrialization on Fertility

**Table 8:** Industrialization and fertility in 1871

|                                | (1)  | (2)                   | (3)                  | (4)                   | (5)                    | (6)                    | (7)                    | (8)                    |
|--------------------------------|--|-----------------------|----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|
|                                | OLS  | OLS                   | OLS                  | OLS                   | IV                     | IV                     | IV                     | IV                     |
|                                | Fertility 1871   |                       |                      |                       |                        |                        |                        |                        |
| Horse Power of Steam Engines   | 0.0006<br>[0.0042]   | 0.0002<br>[0.0032]    | 0.0017<br>[0.0038]   | 0.0018<br>[0.0043]    | -0.0410**<br>[0.0172]  | -0.0133<br>[0.0106]    | -0.0327**<br>[0.0147]  | -0.0485**<br>[0.0205]  |
| Average Altitude               | 0.0028<br>[0.0157]   | 0.0287**<br>[0.0132]  | -0.0116<br>[0.0117]  | 0.0001<br>[0.0160]    | 0.0285<br>[0.0229]     | 0.0387***<br>[0.0140]  | 0.0120<br>[0.0206]     | 0.0435<br>[0.0282]     |
| Average Rainfall               | 0.0525<br>[0.0438]   | -0.0128<br>[0.0415]   | 0.0431<br>[0.0364]   | 0.0401<br>[0.0462]    | 0.0880<br>[0.0666]     | 0.0024<br>[0.0448]     | 0.0740<br>[0.0564]     | 0.158**<br>[0.0780]    |
| Average Temperature            | 0.0066<br>[0.103]  | 0.0452<br>[0.0721]    | -0.1170<br>[0.0764]  | -0.0072<br>[0.105]    | 0.290*<br>[0.164]      | 0.1350<br>[0.0928]     | 0.1360<br>[0.146]      | 0.370*<br>[0.199]      |
| Average Latitude               | 0.0913<br>[0.384]  | 1.113**<br>[0.502]    | -0.2500<br>[0.301]   | 0.0244<br>[0.399]     | 1.625**<br>[0.700]     | 1.518***<br>[0.502]    | 1.070*<br>[0.588]      | 2.016**<br>[0.886]     |
| Average Land Suitability       | -0.106***<br>[0.0370]  | -0.112***<br>[0.0280] | -0.0368<br>[0.0298]  | -0.102***<br>[0.0382] | -0.121***<br>[0.0414]  | -0.116***<br>[0.0256]  | -0.0604<br>[0.0371]    | -0.139***<br>[0.0479]  |
| Maritime Department            |  | 0.0377**<br>[0.0161]  |                      |                       |                        | 0.0450***<br>[0.0157]  |                        |                        |
| Distance to Paris              |  | 0.0002**<br>[0.0001]  |                      |                       |                        | 0.0002*<br>[0.0001]    |                        |                        |
| Paris and Suburbs              |  | 0.0297<br>[0.0330]    |                      |                       |                        | 0.0354<br>[0.0314]     |                        |                        |
| Fertility 1811                 |  |                       | 0.271***<br>[0.0603] |                       |                        |                        | 0.227***<br>[0.0861]   |                        |
| University 1700                |  |                       |                      | 0.0003<br>[0.0175]    |                        |                        |                        | -0.0038<br>[0.0341]    |
| Urban Population 1700          |  |                       |                      | -0.0032<br>[0.00412]  |                        |                        |                        | 0.0179*<br>[0.0106]    |
| Adjusted R2                    | 0.283  | 0.440                 | 0.435                | 0.269                 |                        |                        |                        |                        |
| Observations                   | 82   | 82                    | 82                   | 82                    | 82                     | 82                     | 82                     | 82                     |
|                                | First stage: the instrumented variable is Horse Power of Steam Engines |                       |                      |                       |                        |                        |                        |                        |
| Distance to Fresnes            |  |                       |                      |                       | -0.0087***<br>[0.0022] | -0.0136***<br>[0.0028] | -0.0086***<br>[0.0024] | -0.0073***<br>[0.0020] |
| F-stat (1 <sup>st</sup> stage) |  |                       |                      |                       | 15.206                 | 23.371                 | 12.791                 | 13.641                 |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

The effect of industrialization on the fertility decline over the 1871-1931 period is presented in Tables 8 and 11. The effect of industrialization is negative and significant throughout the period (except in the OLS regressions in 1871 and 1891 in Tables 8 and 9). As shown in the OLS regressions in Column (1) of Tables 10 and 11, the horse power of steam engines in industrial production in 1860-1865 had a negative and significant association with fertility at the 5%-level in 1911 and at the 1%-level in 1931, when one accounts for exogenous geographical factors. This relationship remains significant and negative, mostly smaller in magnitude, once one progressively accounts for the confounding effects of institutional factors (Column (2)), past level of fertility (Column (3)) and pre-industrial characteristics (Column (4)). Finally, mitigating for the effect of omitted variables on the observed relationship, the IV estimates in Columns (5)-(8) of Tables 8 to 10 suggest that the horse power of steam engines in 1860-1865 had a negative and significant impact, either at the

1%- or 5%-level, on fertility in 1871, 1891, 1911 and 1931, accounting for the confounding effects of geographical, institutional, and demographic characteristics.<sup>12</sup>

**Table 9: Industrialization and fertility in 1891**

|  | (1)                 | (2)                    | (3)                  | (4)                  | (5)                    | (6)                    | (7)                    | (8)                    |
|--|---------------------|------------------------|----------------------|----------------------|------------------------|------------------------|------------------------|------------------------|
|  | OLS                 | OLS                    | OLS                  | OLS                  | IV                     | IV                     | IV                     | IV                     |
|  | Fertility 1891      |                        |                      |                      |                        |                        |                        |                        |
| Horse Power of Steam Engines   | -0.0006<br>[0.0033] | -0.0013<br>[0.0023]    | 0.0002<br>[0.0029]   | 0.0001<br>[0.0033]   | -0.0378**<br>[0.0155]  | -0.0130*<br>[0.0074]   | -0.0329**<br>[0.0139]  | -0.0447**<br>[0.0191]  |
| Average Altitude   | -0.0035<br>[0.0128] | 0.0234**<br>[0.0111]   | -0.0130<br>[0.0103]  | -0.0069<br>[0.0134]  | 0.0195<br>[0.0211]     | 0.0321**<br>[0.0125]   | 0.0096<br>[0.0199]     | 0.0317<br>[0.0274]     |
| Average Rainfall   | 0.0331<br>[0.0327]  | -0.0219<br>[0.0253]    | 0.0269<br>[0.0299]   | 0.0253<br>[0.0340]   | 0.0649<br>[0.0584]     | -0.0087<br>[0.0314]    | 0.0565<br>[0.0532]     | 0.130*<br>[0.0706]     |
| Average Temperature  | -0.0436<br>[0.0932] | -0.0055<br>[0.0666]    | -0.125*<br>[0.0714]  | -0.0591<br>[0.0948]  | 0.2100<br>[0.157]      | 0.0728<br>[0.0813]     | 0.1180<br>[0.145]      | 0.2770<br>[0.197]      |
| Average Latitude   | 0.3130<br>[0.334]   | 1.254***<br>[0.466]    | 0.0885<br>[0.267]    | 0.2360<br>[0.346]    | 1.687**<br>[0.687]     | 1.605***<br>[0.498]    | 1.354**<br>[0.610]     | 2.009**<br>[0.881]     |
| Average Land Suitability   | -0.0441<br>[0.0347] | -0.0491*<br>[0.0250]   | 0.0012<br>[0.0290]   | -0.0399<br>[0.0357]  | -0.0575<br>[0.0398]    | -0.0528**<br>[0.0237]  | -0.0214<br>[0.0380]    | -0.0723<br>[0.0469]    |
| Maritime Department  |                     | 0.0428***<br>[0.0139]  |                      |                      |                        | 0.0491***<br>[0.0135]  |                        |                        |
| Distance to Paris  |                     | 0.0002**<br>[9.75e-05] |                      |                      |                        | 0.0002**<br>[8.52e-05] |                        |                        |
| Paris and Suburbs  |                     | 0.0554***<br>[0.0200]  |                      |                      |                        | 0.0603***<br>[0.0212]  |                        |                        |
| Fertility 1811   |                     |                        | 0.178***<br>[0.0570] |                      |                        |                        | 0.136*<br>[0.0785]     |                        |
| University 1700  |                     |                        |                      | -0.0101<br>[0.0127]  |                        |                        |                        | -0.0137<br>[0.0284]    |
| Urban Population 1700  |                     |                        |                      | -0.0012<br>[0.00314] |                        |                        |                        | 0.0176*<br>[0.00947]   |
| Adjusted R2  | 0.159               | 0.456                  | 0.271                | 0.145                |                        |                        |                        |                        |
| Observations   | 82                  | 82                     | 82                   | 82                   | 82                     | 82                     | 82                     | 82                     |
| First stage: the instrumented variable is Horse Power of Steam Engines |                     |                        |                      |                      |                        |                        |                        |                        |
| Distance to Fresnes  |                     |                        |                      |                      | -0.0087***<br>[0.0022] | -0.0136***<br>[0.0028] | -0.0086***<br>[0.0024] | -0.0073***<br>[0.0020] |
| F-stat (1 <sup>st</sup> stage)   |                     |                        |                      |                      | 15.206                 | 23.371                 | 12.791                 | 13.641                 |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

The IV regressions in Tables 8-11 also account for a large number of confounding geographical and institutional factors. In particular, the climatic and soil characteristics of each department (i.e., altitude, land suitability, average temperature, average rainfall, and latitude) could have affected natural land productivity and therefore the feasibility and profitability of the transition to the industrial stage of development, as well as the evolution of income per capita and its potential direct on fertility in each department. In the IV regressions in Columns (5)-(8) of Tables 8-11, average rainfall, latitude and temperature have a significant and positive association with fertility. Moreover, land suitability has a negative but mostly insignificant correlation in these IV regressions while average altitude has a positive and mostly insignificant one.

Beside, the location of departments (i.e., maritime departments and departments at a greater distance from the concentration of political power in Paris) could have affected the diffusion of the steam engine and fertility. In the IV regressions in Tables 8 to 11, we find that maritime departments

<sup>12</sup>The F-statistic in the first stage is equal to 23.37 in Tables 8-10 and to 24.04 in Table 11 when the geographical and institutional controls are included in Column (6). Furthermore, the IV coefficient in each specification is larger than the OLS coefficient, which can probably be attributed to measurement error in the explanatory variable – the horse power of steam engines.

**Table 10:** Industrialization and fertility in 1911

|  | (1)                   | (2)                    | (3)                   | (4)                  | (5)                    | (6)                    | (7)                    | (8)                    |
|--|-----------------------|------------------------|-----------------------|----------------------|------------------------|------------------------|------------------------|------------------------|
|  | OLS                   | OLS                    | OLS                   | OLS                  | IV                     | IV                     | IV                     | IV                     |
|  | Fertility 1911        |                        |                       |                      |                        |                        |                        |                        |
| Horse Power of Steam Engines   | -0.0050**<br>[0.0024] | -0.0050**<br>[0.0019]  | -0.0049**<br>[0.0024] | -0.0037*<br>[0.0022] | -0.0299***<br>[0.0070] | -0.0132***<br>[0.0045] | -0.0302***<br>[0.0078] | -0.0333***<br>[0.0089] |
| Average Altitude   | -0.002<br>[0.0081]    | 0.0117*<br>[0.0069]    | -0.003<br>[0.0076]    | -0.007<br>[0.0078]   | 0.014<br>[0.0113]      | 0.0178***<br>[0.0065]  | 0.015<br>[0.0122]      | 0.019<br>[0.0146]      |
| Average Rainfall   | 0.0693***<br>[0.0220] | 0.027<br>[0.0186]      | 0.0685***<br>[0.0223] | 0.0545**<br>[0.0224] | 0.0905**<br>[0.0383]   | 0.036<br>[0.0241]      | 0.0911**<br>[0.0394]   | 0.124***<br>[0.0409]   |
| Average Temperature  | -0.013<br>[0.0486]    | 0.007<br>[0.0339]      | -0.024<br>[0.0447]    | -0.038<br>[0.0470]   | 0.156**<br>[0.0730]    | 0.062<br>[0.0414]      | 0.163**<br>[0.0814]    | 0.184**<br>[0.0936]    |
| Average Latitude   | 0.497***<br>[0.184]   | 1.054***<br>[0.221]    | 0.468***<br>[0.174]   | 0.373**<br>[0.182]   | 1.413***<br>[0.286]    | 1.301***<br>[0.181]    | 1.438***<br>[0.312]    | 1.544***<br>[0.381]    |
| Average Land Suitability   | -0.015<br>[0.0151]    | -0.0192**<br>[0.00934] | -0.009<br>[0.0154]    | -0.008<br>[0.0154]   | -0.024<br>[0.0214]     | -0.0218**<br>[0.00963] | -0.026<br>[0.0226]     | -0.030<br>[0.0246]     |
| Maritime Department  |                       | 0.0183**<br>[0.00803]  |                       |                      |                        | 0.0228***<br>[0.00845] |                        |                        |
| Distance to Paris  |                       | 0.0001**<br>[5.02e-05] |                       |                      |                        | 0.0001**<br>[4.84e-05] |                        |                        |
| Paris and Suburbs  |                       | -0.011<br>[0.0106]     |                       |                      |                        | -0.007<br>[0.0069]     |                        |                        |
| Fertility 1811   |                       |                        | 0.023<br>[0.0374]     |                      |                        |                        | -0.010<br>[0.0547]     |                        |
| University 1700  |                       |                        |                       | -0.013<br>[0.00775]  |                        |                        |                        | -0.015<br>[0.0184]     |
| Urban Population 1700  |                       |                        |                       | -0.003<br>[0.00218]  |                        |                        |                        | 0.00964*<br>[0.00547]  |
| Adjusted R2  | 0.349                 | 0.541                  | 0.344                 | 0.376                |                        |                        |                        |                        |
| Observations   | 82                    | 82                     | 82                    | 82                   | 82                     | 82                     | 82                     | 82                     |
| First stage: the instrumented variable is Horse Power of Steam Engines |                       |                        |                       |                      |                        |                        |                        |                        |
| Distance to Fresnes  |                       |                        |                       |                      | -0.0087***<br>[0.0022] | -0.0136***<br>[0.0028] | -0.0086***<br>[0.0024] | -0.0073***<br>[0.0020] |
| F-stat (1 <sup>st</sup> stage)   |                       |                        |                       |                      | 15.206                 | 23.371                 | 12.791                 | 13.641                 |

Note: Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

and those at a greater distance from Paris are positively and significantly associated with fertility in 1871, 1891 and 1911, but these relationships are not significant in 1931. Moreover the dummy variable for Paris and its suburbs has a positive correlation with fertility which is insignificant in 1871 but significant in 1891, and a negative correlation with fertility which is insignificant in 1911 but significant in 1931.

In addition, we account for the past level of fertility in each department, as measured in 1811 in our regressions. In the IV regressions of Tables 8 and 9, fertility in 1811 is positively correlated with fertility in 1871 and 1891, and this relationship is significant at the 10%-level in 1891 in Column (7) in Table 9. However, in the IV regressions of Tables 10 and 11, fertility in 1811 is negatively correlated with fertility in 1911 and 1931, and this relationship is significant at the 5%-level in 1931 in Column (7) in Table 11. This result reflects the general trend toward low fertility rates in France, whereby departments with high fertility rates in France at the beginning of the 19th century experienced a larger drop in fertility in the following decades.

The regressions in Tables 10 and 11 also take into account the potentially confounding effects of the level of human capital and economic development in the pre-industrial period, as captured by the presence of universities and urban population in 1700. In the IV regressions in Column (8) of Tables 10 and 11, we find that the presence of a university in 1700 had a negative impact

**Table 11:** Industrialization and fertility in 1931

|                                | (1)  | (2)                    | (3)                    | (4)                     | (5)                      | (6)                    | (7)                    | (8)                    |
|--------------------------------|--|------------------------|------------------------|-------------------------|--------------------------|------------------------|------------------------|------------------------|
|                                | OLS  | OLS                    | OLS                    | OLS                     | IV                       | IV                     | IV                     | IV                     |
|                                | Fertility 1931   |                        |                        |                         |                          |                        |                        |                        |
| Horse Power of Steam Engines   | -0.0047***<br>[0.0016]   | -0.0040***<br>[0.0014] | -0.0048***<br>[0.0016] | -0.0032**<br>[0.0012]   | -0.0153***<br>[0.0047]   | -0.0096***<br>[0.0029] | -0.0179***<br>[0.0051] | -0.0154***<br>[0.0047] |
| Average Altitude               | -0.0114**<br>[0.00518]   | -0.0107**<br>[0.00488] | -0.0079<br>[0.00587]   | -0.0169***<br>[0.00418] | -0.0039<br>[0.00664]     | -0.0066<br>[0.00501]   | 0.0012<br>[0.00755]    | -0.0069<br>[0.00728]   |
| Average Rainfall               | 0.0487***<br>[0.0161]  | 0.0287**<br>[0.0140]   | 0.0520***<br>[0.0155]  | 0.0319**<br>[0.0155]    | 0.0603***<br>[0.0212]    | 0.0357**<br>[0.0168]   | 0.0650***<br>[0.0228]  | 0.0613***<br>[0.0231]  |
| Average Temperature            | -0.0501**<br>[0.0240]  | -0.0451**<br>[0.0223]  | -0.0223<br>[0.0267]    | -0.0764***<br>[0.0213]  | 0.0275<br>[0.0463]       | -0.0080<br>[0.0305]    | 0.0760<br>[0.0518]     | 0.0146<br>[0.0484]     |
| Average Latitude               | 0.387***<br>[0.0946]   | 0.546***<br>[0.140]    | 0.471***<br>[0.101]    | 0.260***<br>[0.0836]    | 0.804***<br>[0.198]      | 0.703***<br>[0.148]    | 0.978***<br>[0.211]    | 0.738***<br>[0.197]    |
| Average Land Suitability       | 0.0124<br>[0.00762]  | 0.0086<br>[0.00758]    | -0.0024<br>[0.00927]   | 0.0197**<br>[0.00827]   | 0.0065<br>[0.0121]       | 0.0066<br>[0.00895]    | -0.0127<br>[0.0141]    | 0.0106<br>[0.0125]     |
| Maritime Department            |  | -0.0041<br>[0.00531]   |                        |                         |                          | -0.0009<br>[0.00592]   |                        |                        |
| Distance to Paris              |  | 0.00004<br>[3.36e-05]  |                        |                         |                          | 0.00002<br>[3.35e-05]  |                        |                        |
| Paris and Suburbs              |  | -0.0501***<br>[0.0176] |                        |                         |                          | -0.0479***<br>[0.0136] |                        |                        |
| Fertility 1811                 |  |                        | -0.0548**<br>[0.0226]  |                         |                          |                        | -0.0737**<br>[0.0308]  |                        |
| University 1700                |  |                        |                        | -0.0144***<br>[0.00544] |                          |                        |                        | -0.0166**<br>[0.00846] |
| Urban Population 1700          |  |                        |                        | -0.0033**<br>[0.0014]   |                          |                        |                        | 0.0016<br>[0.0025]     |
| Alsace-Lorraine                |  | -0.0174<br>[0.0131]    | -0.0110<br>[0.0109]    | -0.0004<br>[0.0132]     |                          | -0.0091<br>[0.0133]    | 0.0023<br>[0.0145]     | 0.0063<br>[0.0119]     |
| Adjusted R2                    | 0.502  | 0.623                  | 0.527                  | 0.578                   |                          |                        |                        |                        |
| Observations                   | 85   | 85                     | 85                     | 85                      | 85                       | 85                     | 85                     | 85                     |
|                                | First stage: the instrumented variable is Horse Power of Steam Engines |                        |                        |                         |                          |                        |                        |                        |
| Distance to Fresnes            |  |                        |                        |                         | -0.00838***<br>[0.00225] | -0.0138***<br>[0.0028] | -0.0088***<br>[0.0024] | -0.0077***<br>[0.0020] |
| F-stat (1 <sup>st</sup> stage) |  |                        |                        |                         | 13.878                   | 24.042                 | 13.722                 | 15.585                 |

Note: The post-WWI regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

on fertility, although this variable is only significant (at the 5%-level) in 1931 while the urban population in 1700 had a positive impact on fertility, which is significant at the 10%-level in 1871, 1891 and 1911 but not in 1931.

Furthermore, the IV estimates in Column (6) of Tables 10 and 11 suggest that the presence of steam engines had substantial quantitative effects on fertility: a one-percent increase in the horse power of steam engines in a department in 1860-1865 decreased fertility by 1.33% in 1891, 1.30% in 1891, 1.32% in 1911 and 0.96% in 1931. As such, if a department had increased its total horse power of steam engines in 1860-1865 from the 25th percentile (241 hp) to the 75th percentile (1768 hp) of the distribution, it would have experienced a fertility decline of 1.81% in 1871, 1.77% in 1891, 1.80% in 1911 and 1.31% in 1931.

Finally, the association between the horse power of steam engines and fertility over the 1871-1931 period is not affected by spatial correlation as established in Table C.1 in Appendix C.

### **4.3 Robustness Analysis**

This section examines the robustness of the baseline analysis to the inclusion of an additional set of confounding geographical, demographic, political and institutional characteristics, as well as for the forces of pre-industrial development, which may have contributed to the relationship between industrialization and economic development. The analysis focuses on the potential impact of these confounding factors on the baseline IV regressions in Tables 10 and 11, where the dependent variables are the fertility rates in 1911 and in 1931. As will become apparent, some of these confounding factors could be viewed as endogenous to the adoption of the steam engine and are thus not part of the baseline analysis.

#### **4.3.1 Access to Waterways**

The diffusion of the steam engine may have been affected by the trade potential of each department, as captured by the presence of rivers and their main tributaries within the perimeter of the department. Using data on the paths of the Rhine, Loire, Meuse, Rhône, Seine and Garonne rivers as well as of their major tributaries (Dordogne, Charente and Escaut), Table B.3 establishes that a direct access to a river path, and thus to a major port, has no qualitative impact on the estimated effect of industrialization on fertility.

#### **4.3.2 The Presence of Raw Material**

The presence of raw material required for industrialization could have affected the adoption of the steam engine across French departments, the process of development, and ultimately, fertility. Nevertheless, as established in Table B.4, accounting for the number of iron forges in 1789 and 1811 in each department (Woronoff, 1997), the effect of industrialization on fertility in the process of development remains nearly intact, economically and statistically. Moreover, as shown in Table B.5, accounting for the area covered by coal mines in 1837 in each department, the effect of industrialization on fertility remains qualitatively intact.

#### **4.3.3 Economic Integration**

The diffusion of the steam engine across French departments and fertility could have been affected by the geographical and economic integration of each department into the French economy. First, as reported in Table B.6, the degree of market integration of each department, as captured by the number of its external suppliers in the 1790s (Daudin, 2010), has no qualitative impact on the effect of industrialization on fertility in the process of development. Second, as reported in

Table B.7, accounting for the presence of railroad connection in 1860 (Caron, 1997),<sup>13</sup> the effect of industrialization on fertility in the process of development remains nearly intact, economically and statistically.

#### 4.3.4 Industrial Concentration

The degree of industrial concentration in each department could have affected the diffusion of the steam engine across French departments and the process of development, and thus fertility rates. Nevertheless, as reported in Table B.8, accounting for the degree of industrial concentration in the 1860-1865 period, proxied by the Hirfendahl index of the 16 different industries listed in the 1860-1865 industrial survey (textile, mines, metallurgy, metal objects, leather, wood, ceramics, chemistry, construction, lighting, furniture, clothing, food, transportation, sciences & arts, and luxury goods), the effect of industrialization on fertility in the process of development remains nearly intact, economically and statistically.<sup>14</sup>

#### 4.3.5 Population Density

In light of the evidence that steam engines were more likely to be located in urban centers (Rosenberg and Trajtenberg, 2004), it is plausible that the adoption of the steam engine was influenced by the contemporaneous but potentially endogenous level of population density at the time. Reassuringly, as established in Table B.9 in Appendix B, the inclusion of population density in each French department in 1801, 1831 and 1861 has no qualitative impact on the estimated effects of industrialization or on the statistical significance of these effects. Accounting for the confounding effects of exogenous geographical, institutional, and pre-industrial characteristics, the horse power of steam engines in industrial production in the 1860-1865 period had a negative and significant impact on fertility in 1911 and 1931.

#### 4.3.6 Share of Catholics in the Population

In light of the potential relationship between religion, fertility and entrepreneurial activities (see the discussion in, e.g., Weber, 1930; Botticini and Eckstein, 2005; Becker and Woessmann, 2009; Franck and Iannaccone, 2014; Cantoni, 2015), the adoption of the steam engine in France and fertility could have been affected by variations in the share of Catholics across departments, as opposed to the the other religious minorities in France (Jews, Calvinist Protestants, Lutheran

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<sup>13</sup>The early network was built around seven lines in order to connect Paris to the main economic centres of the country (Caron, 1997).

<sup>14</sup>The Herfindahl index of industry concentration is defined as,  $H_d = \sum_{i=1}^{16} (E_{i,d}/E_d)^2$ , where  $H_d$  is the Herfindahl concentration index for department  $d$ ,  $E_{i,d}$  is the horse power of the steam engines in the firms in sector  $i$  of department  $d$  and  $E_d$  is the horse power of the steam engines in the firms of department  $d$ .

Protestants, etc...). As shown in Table B.10, accounting for the share of Catholics in the French population in 1861 (i.e., when the industrial survey was carried out) has no qualitative impact on the effect of industrialization on fertility in 1911 and 1931.

### **4.3.7 Past Levels of Human Capital**

Considering evidence about capital-skill complementarity as well as the comparative advantage of educated individuals in adopting new technologies (Nelson and Phelps, 1966; Jovanovic and Rousseau, 2005), the diffusion of the steam engine and fertility could have been both affected by the level of human capital in each department. Using data on the percentage of grooms who could sign their marriage license in 1686-1690, 1786-1790 and 1816-1820 (Furet and Ozouf, 1977), it appears in Table B.11 that early levels of human capital have no qualitative impact on the estimated effects of industrialization on fertility in 1911 and 1931.

### **4.3.8 World War I**

World War I, and the associated destruction of physical and human capital, may have affected disproportionately industrial centers, thereby potentially affecting the decline in fertility. However, accounting for the destruction of physical and human capital does not affect the qualitative results. Specifically, in (Table B.16), neither the number of buildings destroyed in each department in WWI nor the number of soldiers from each department who died in the war has a qualitative impact on the effect of industrialization on fertility in 1931.

## **5 Conclusion**

The study provides the first empirical examination of the hypothesized effect of industrialization on the fertility decline. It establishes that the number of steam engines in industrial production in the 1860-1865 period had a positive and significant impact on the decline in fertility in the 1871-1931 period.

Moreover, the analysis suggests that the contribution of industrialization to the decline in fertility plausibly operated through the effect of industrialization on human capital formation, rather than through the rise in income that was brought about by the process of industrialization, or the decline in mortality which took place over this time period. The research therefore confirms one of the central elements of Unified Growth Theory which hypothesizes that a critical force in the transition from stagnation to growth was the impact of industrialization on the onset of the demographic transition, via the rise in the demand for human capital.



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# Appendix A. Descriptive statistics

**Table A.1:** Descriptive statistics

|  | Obs | Mean          | Std.Dev. | Min.    | Max.   |
|--|-----|---------------|----------|---------|--------|
| <i>Fertility</i>   |     |               |          |         |        |
| Fertility 1931   | 85  | 0.19          | 0.03     | 0.13    | 0.25   |
| Fertility 1911   | 82  | 0.21          | 0.03     | 0.14    | 0.30   |
| Fertility 1891   | 82  | 0.25          | 0.05     | 0.16    | 0.45   |
| Fertility 1871   | 82  | 0.28          | 0.06     | 0.18    | 0.50   |
| Fertility 1811   | 85  | 0.40          | 0.11     | 0.24    | 0.87   |
| <i>Income</i>  |     |               |          |         |        |
| GDP per capita, 1872   | 82  | 666.1         | 192.6    | 235.6   | 1197   |
| GDP per capita, 1886   | 82  | 756.3         | 243.1    | 266.9   | 1383   |
| GDP per capita, 1911   | 82  | 906.3         | 310.1    | 377.5   | 2078.7 |
| GDP per capita, 1931   | 84  | 6461.9 1520.9 | 4033.5   | 14109.9 |        |
| <i>Human capital</i>   |     |               |          |         |        |
| Share of Literate Conscripts, 1872   | 82  | 0.002         | 0.004    | 0       | 0.018  |
| Share of Literate Conscripts, 1892   | 82  | 0.02          | 0.008    | 0.002   | 0.049  |
| Share of Literate Conscripts, 1911   | 82  | 0.02          | 0.009    | 0.002   | 0.048  |
| Share of Literate Conscripts, 1931   | 85  | 0.033         | 0.011    | 0.016   | 0.061  |
| Share of High-School Graduates among Conscripts, 1872                              | 82  | 0.002         | 0.004    | 0       | 0.02   |
| Share of High-School Graduates among Conscripts, 1892                              | 82  | 0.017         | 0.008    | 0.002   | 0.049  |
| Share of High-School Graduates among Conscripts, 1911                              | 82  | 0.02          | 0.01     | .002    | 0.048  |
| Share of High-School Graduates among Conscripts, 1931                              | 85  | 0.03          | 0.011    | 0.016   | .061   |
| <i>Mortality at age 0-1</i>  |     |               |          |         |        |
| Mortality Age 0-1, 1871  | 82  | 0.30          | 0.08     | 0       | 0.49   |
| Mortality Age 0-1, 1891  | 82  | 0.22          | 0.06     | 0       | 0.40   |
| Mortality Age 0-1, 1911  | 82  | 0.04          | 0.01     | 0.02    | 0.07   |
| <i>Life expectancy at age 15</i>   |     |               |          |         |        |
| Life Expectancy Age 15, 1871   | 82  | 43.72         | 3.18     | 38.04   | 63.31  |
| Life Expectancy Age 15, 1891   | 82  | 46.54         | 2.01     | 40.33   | 49.74  |
| Life Expectancy Age 15, 1911   | 82  | 64.23         | 2.05     | 47.58   | 65.91  |
| <i>Wage gender gap</i>   |     |               |          |         |        |
| Male-to-female wage ratio, 1891  | 82  | 2.04          | 0.57     | 1.14    | 4.48   |
| Male-to-female wage ratio, 1911  | 78  | 2.16          | 0.43     | 1.55    | 3.83   |
| <i>Industrialization</i>   |     |               |          |         |        |
| Horse Power of Steam Engines   | 85  | 1917.7        | 3928.4   | 0       | 27638  |
| <i>Geographic, institutional and pre-industrial characteristics of departments</i> |     |               |          |         |        |
| Average Altitude   | 85  | 319.9         | 296.3    | 36.0    | 1729.2 |
| Average Rainfall   | 85  | 872.2         | 152.1    | 642.9   | 1289.2 |
| Average Temperature  | 85  | 10.6          | 1.5      | 4.6     | 13.7   |
| Latitude   | 85  | 46.6          | 2.1      | 42.6    | 50.5   |
| Land Suitability   | 85  | 0.75          | 0.18     | 0.2     | 0.98   |
| Maritime Department  | 85  | 0.26          | 0.44     | 0       | 1      |
| Distance to Paris  | 85  | 353.7         | 179.53   | 1       | 686.8  |
| Paris and Suburbs  | 85  | 0.04          | 0.19     | 0       | 1      |
| Alsace-Lorraine  | 85  | 0.04          | 0.19     | 0       | 1      |
| Urban Population in 1700 (thousand of inhabitants)                                 | 85  | 21.76         | 58.96    | 0       | 510    |
| University   | 85  | 0.19          | 0.39     | 0       | 1      |
| <i>Instrumental variable</i>   |     |               |          |         |        |
| Distance to Fresnes sur Escaut   | 85  | 485.44        | 216.60   | 42.88   | 862.60 |

**Table A.2:** Descriptive statistics: variables for robustness analysis.

|  | Obs | Mean     | Std.Dev. | Min.  | Max.   |
|--|-----|----------|----------|-------|--------|
| <i>Distance from French cities - aerial distance</i> |     |          |          |       |        |
| Distance from Lyon                                   | 85  | 334.58   | 149.94   | 1     | 723.27 |
| Distance from Marseille                              | 85  | 483.10   | 215.25   | 1     | 902.67 |
| Distance from Mulhouse                               | 85  | 456.25   | 187.92   | 36.61 | 853.41 |
| Distance from Bordeaux                               | 85  | 398.27   | 171.53   | 1     | 759.49 |
| Distance from Rouen                                  | 85  | 405.73   | 199.18   | 0     | 774.94 |
| <i>Distance from French cities - weeks of travel</i> |     |          |          |       |        |
| Distance from Fresnes (weeks of travel)              | 85  | 0.47     | 0.18     | 0.05  | 0.86   |
| Distance from Paris (weeks of travel)                | 85  | 0.39     | 0.17     | 0.00  | 0.69   |
| Distance from Lyon (weeks of travel)                 | 85  | 0.43     | 0.23     | 0.03  | 0.96   |
| Distance from Marseille (weeks of travel)            | 85  | 0.51     | 0.23     | 0.04  | 1.00   |
| Distance from Mulhouse (weeks of travel)             | 85  | 0.64     | 0.29     | 0.01  | 1.13   |
| Distance from Bordeaux (weeks of travel)             | 85  | 0.51     | 0.27     | 0.00  | 1.12   |
| Distance from Rouen (weeks of travel)                | 85  | 0.44     | 0.20     | 0.02  | 0.84   |
| <i>Access to waterways</i>                           |     |          |          |       |        |
| Rivers and Tributaries                               | 85  | 0.56     | 0.50     | 0     | 1      |
| <i>Economic integration</i>                          |     |          |          |       |        |
| Market integration during the French Revolution      | 84  | 134.68   | 107.44   | 21    | 732    |
| Railroad connection to Paris in 1860                 | 85  | 0.73     | 0.45     | 0     | 1      |
| <i>The presence of raw materials</i>                 |     |          |          |       |        |
| Area covered by mines in department                  | 85  | 4699.318 | 9115.352 | 0     | 49248  |
| Iron forges in 1789                                  | 85  | 2.25     | 8.95     | 0     | 52     |
| Iron forges in 1811                                  | 85  | 2.65     | 11.34    | 0     | 79     |
| <i>Industrial concentration</i>                      |     |          |          |       |        |
| Concentration Index, 1861                            | 81  | 0.39     | 0.20     | 0.12  | 1      |
| <i>Population density</i>                            |     |          |          |       |        |
| Population density 1801                              | 84  | 0.75     | 1.55     | 0.19  | 13.17  |
| Population density 1831                              | 85  | 0.92     | 2.19     | 0.22  | 19.50  |
| Population density 1861                              | 85  | 1.24     | 4.42     | 0.21  | 40.74  |
| <i>Share of Catholics in the population in 1861</i>  |     |          |          |       |        |
| Share Catholics 1861                                 | 85  | 0.97     | 0.06     | 0.65  | 1.00   |
| <i>Past levels of human capital</i>                  |     |          |          |       |        |
| Grooms who signed their marriage license, 1686-1690  | 76  | 0.26     | 0.15     | 0.06  | 0.64   |
| Grooms who signed their marriage license, 1786-1790  | 79  | 0.42     | 0.24     | 0.05  | 0.92   |
| Grooms who signed their marriage license, 1816-1820  | 78  | 0.51     | 0.22     | 0.13  | 0.96   |
| <i>World War I</i>                                   |     |          |          |       |        |
| Destroyed Buildings WWI                              | 85  | 10929.91 | 38913.23 | 0     | 280175 |
| Soldier deaths in World War I                        | 85  | 14478.67 | 10520.44 | 893   | 80591  |



**Table B.2:** The determinants of the diffusion of the steam engine: distances from Fresnes-sur-Escaut and other major French cities by foot measured in travel weeks

|   | (1)                          | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  | (7)                  |
|---|------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|   | OLS                          | OLS                  | OLS                  | OLS                  | OLS                  | OLS                  | OLS                  |
|   | Horse Power of Steam Engines |                      |                      |                      |                      |                      |                      |
| Distance to Fresnes (Weeks of Travel)   | -6.072***<br>[0.992]         | -8.185***<br>[1.568] | -5.930***<br>[0.950] | -6.283***<br>[1.076] | -6.266***<br>[1.033] | -5.944***<br>[1.173] | -5.645***<br>[1.243] |
| Distance to Paris (Weeks of Travel)     |                              | 2.861<br>[1.763]     |                      |                      |                      |                      |                      |
| Distance to Marseille (Weeks of Travel) |                              |                      | 0.803<br>[0.816]     |                      |                      |                      |                      |
| Distance to Lyon (Weeks of Travel)      |                              |                      |                      | 0.539<br>[0.811]     |                      |                      |                      |
| Distance to Rouen (Weeks of Travel)     |                              |                      |                      |                      | 0.386<br>[1.003]     |                      |                      |
| Distance to Mulhouse (Weeks of Travel)  |                              |                      |                      |                      |                      | -0.192<br>[0.741]    |                      |
| Distance to Bordeaux (Weeks of Travel)  |                              |                      |                      |                      |                      |                      | 0.635<br>[0.884]     |
| Adjusted R2                             | 0.296                        | 0.307                | 0.296                | 0.291                | 0.289                | 0.288                | 0.293                |
| Observations                            | 85                           | 85                   | 85                   | 85                   | 85                   | 85                   | 85                   |

Note: The dependent variable is in logarithm. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.3:** Industrialization and the evolution of fertility, accounting for the presence of rivers and their main tributaries within departments

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]      | -0.0128**<br>[0.00635]      | -0.0107***<br>[0.00316]     | -0.0107***<br>[0.00368]     |
| Rivers and Tributaries   |                             | -0.0009<br>[0.00859]        |                             | -0.00004<br>[0.00478]       |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0157*<br>[0.00874]        | -0.0046<br>[0.00570]        | -0.0046<br>[0.00618]        |
| Average Rainfall   | 0.0321<br>[0.0263]          | 0.0322<br>[0.0258]          | 0.0327*<br>[0.0178]         | 0.0327*<br>[0.0175]         |
| Average Temperature  | 0.0550<br>[0.0539]          | 0.0541<br>[0.0587]          | 0.0179<br>[0.0364]          | 0.0178<br>[0.0392]          |
| Average Latitude   | 1.247***<br>[0.236]         | 1.240***<br>[0.278]         | 0.794***<br>[0.183]         | 0.793***<br>[0.204]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0210*<br>[0.0127]        | -0.0071<br>[0.0104]         | -0.0071<br>[0.0106]         |
| Maritime Department  | 0.0238***<br>[0.0087]       | 0.0235***<br>[0.0089]       | 0.0010<br>[0.0056]          | 0.0010<br>[0.0057]          |
| Distance to Paris  | 0.0001**<br>[4.76e-05]      | 0.0001**<br>[4.78e-05]      | 0.00003<br>[2.98e-05]       | 0.00003<br>[3.00e-05]       |
| Paris and Suburbs  | -0.0066<br>[0.00702]        | -0.0065<br>[0.00682]        | -0.0466***<br>[0.0116]      | -0.0466***<br>[0.0115]      |
| Fertility 1811   | -0.0112<br>[0.0299]         | -0.0111<br>[0.0297]         | -0.0704***<br>[0.0205]      | -0.0704***<br>[0.0207]      |
| University 1700  | -0.0114<br>[0.0078]         | -0.0111<br>[0.0078]         | -0.0139**<br>[0.0061]       | -0.0139**<br>[0.0060]       |
| Urban Population 1700  | -0.0002<br>[0.00252]        | -0.0002<br>[0.00261]        | -0.00001<br>[0.00178]       | -0.00001<br>[0.00182]       |
| Alsace-Lorraine  |                             |                             | -0.0052<br>[0.0096]         | -0.0052<br>[0.0094]         |
| Observations   | 82                          | 82                          | 85                          | 85                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.00928***<br>[0.00235]    | -0.0113***<br>[0.00256]     | -0.00952***<br>[0.00232]    |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 15.596                      | 19.385                      | 16.830                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.4:** Industrialization and the evolution of fertility, accounting for iron forges before 1811

|  | (1)                      | (2)                      | (3)                      | (4)                     | (5)                     | (6)                     |
|--|--------------------------|--------------------------|--------------------------|-------------------------|-------------------------|-------------------------|
|  | IV                       | IV                       | IV                       | IV                      | IV                      | IV                      |
|  | Fertility 1911           |                          |                          | Fertility 1931          |                         |                         |
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]   | -0.0134**<br>[0.00554]   | -0.0133**<br>[0.00554]   | -0.0107***<br>[0.00316] | -0.0110***<br>[0.00333] | -0.0110***<br>[0.00334] |
| Iron Forges 1789   |                          | 0.0013<br>[0.00194]      |                          |                         | 0.0010<br>[0.00165]     |                         |
| Iron Forges 1811   |                          |                          | 0.0013<br>[0.00186]      |                         |                         | 0.0010<br>[0.00158]     |
| Average Altitude   | 0.0159**<br>[0.00785]    | 0.0165**<br>[0.00810]    | 0.0165**<br>[0.00810]    | -0.0046<br>[0.00570]    | -0.0041<br>[0.00592]    | -0.0041<br>[0.00593]    |
| Average Rainfall   | 0.0321<br>[0.0263]       | 0.0314<br>[0.0266]       | 0.0314<br>[0.0266]       | 0.0327*<br>[0.0178]     | 0.0322*<br>[0.0180]     | 0.0322*<br>[0.0180]     |
| Average Temperature  | 0.0550<br>[0.0539]       | 0.0593<br>[0.0558]       | 0.0592<br>[0.0559]       | 0.0179<br>[0.0364]      | 0.0210<br>[0.0378]      | 0.0211<br>[0.0379]      |
| Average Latitude   | 1.247***<br>[0.236]      | 1.272***<br>[0.246]      | 1.272***<br>[0.247]      | 0.794***<br>[0.183]     | 0.811***<br>[0.192]     | 0.812***<br>[0.193]     |
| Average Land Suitability   | -0.0211*<br>[0.0127]     | -0.0226*<br>[0.0135]     | -0.0226*<br>[0.0136]     | -0.0071<br>[0.0104]     | -0.0082<br>[0.0109]     | -0.0082<br>[0.0109]     |
| Maritime Department  | 0.0238***<br>[0.00870]   | 0.0242***<br>[0.00894]   | 0.0242***<br>[0.00892]   | 0.0010<br>[0.00555]     | 0.0013<br>[0.00567]     | 0.0013<br>[0.00567]     |
| Distance to Paris  | 0.000104**<br>[4.76e-05] | 0.000106**<br>[4.75e-05] | 0.000106**<br>[4.75e-05] | 0.00003<br>[2.98e-05]   | 0.00003<br>[3.05e-05]   | 0.00003<br>[3.05e-05]   |
| Paris and Suburbs  | -0.0066<br>[0.00702]     | -0.0059<br>[0.00737]     | -0.0059<br>[0.00737]     | -0.0466***<br>[0.0116]  | -0.0461***<br>[0.0118]  | -0.0461***<br>[0.0118]  |
| Fertility 1811   | -0.0112<br>[0.0299]      | -0.0166<br>[0.0343]      | -0.0165<br>[0.0342]      | -0.0704***<br>[0.0205]  | -0.0744***<br>[0.0232]  | -0.0746***<br>[0.0232]  |
| University 1700  | -0.0114<br>[0.00777]     | -0.0119<br>[0.00812]     | -0.0119<br>[0.00810]     | -0.0139**<br>[0.00605]  | -0.0143**<br>[0.00631]  | -0.0143**<br>[0.00630]  |
| Urban Population 1700  | -0.0002<br>[0.00252]     | -0.00004<br>[0.00257]    | -0.00004<br>[0.00257]    | -0.00001<br>[0.00178]   | 0.0001<br>[0.00184]     | 0.0001<br>[0.00184]     |
| Alsace-Lorraine  |                          |                          |                          | -0.0052<br>[0.00958]    | -0.0048<br>[0.00961]    | -0.0048<br>[0.00960]    |
| Observations   | 82                       | 82                       | 82                       | 85                      | 85                      | 85                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                          |                          |                          |                         |                         |                         |
| Distance to Fresnes  | -0.0110***<br>[0.00257]  | -0.0107***<br>[0.00269]  | -0.0107***<br>[0.00269]  | -0.0113***<br>[0.00256] | -0.0110***<br>[0.00269] | -0.0110***<br>[0.00268] |
| F-stat (1 <sup>st</sup> stage)   | 18.218                   | 15.906                   | 15.893                   | 19.385                  | 16.777                  | 16.800                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level,

\*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.



**Table B.5:** Industrialization and the evolution of fertility, accounting for mines in 1837

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.0053]       | -0.0160**<br>[0.0067]       | -0.0107***<br>[0.0032]      | -0.0129***<br>[0.0039]      |
| Area Covered by Mines in Department                                    |                             | 0.0049<br>[0.0030]          |                             | 0.0038**<br>[0.0018]        |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0112*<br>[0.00666]        | -0.0046<br>[0.00570]        | -0.0081<br>[0.00503]        |
| Average Rainfall   | 0.0321<br>[0.0263]          | 0.0495<br>[0.0344]          | 0.0327*<br>[0.0178]         | 0.0453**<br>[0.0229]        |
| Average Temperature  | 0.0550<br>[0.0539]          | 0.0585<br>[0.0545]          | 0.0179<br>[0.0364]          | 0.0207<br>[0.0348]          |
| Average Latitude   | 1.247***<br>[0.236]         | 1.222***<br>[0.236]         | 0.794***<br>[0.183]         | 0.767***<br>[0.156]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0184<br>[0.0129]         | -0.0071<br>[0.0104]         | -0.0056<br>[0.00982]        |
| Maritime Department  | 0.0238***<br>[0.00870]      | 0.0193**<br>[0.00938]       | 0.0010<br>[0.00555]         | -0.0023<br>[0.00541]        |
| Distance to Paris  | 0.000104**<br>[4.76e-05]    | 0.0001<br>[5.95e-05]        | 0.0000<br>[2.98e-05]        | 0.0000<br>[3.62e-05]        |
| Paris and Suburbs  | -0.0066<br>[0.00702]        | -0.0063<br>[0.00753]        | -0.0466***<br>[0.0116]      | -0.0468***<br>[0.0115]      |
| Fertility 1811   | -0.0112<br>[0.0299]         | -0.0186<br>[0.0345]         | -0.0704***<br>[0.0205]      | -0.0773***<br>[0.0212]      |
| University 1700  | -0.0114<br>[0.00777]        | -0.0168*<br>[0.00932]       | -0.0139**<br>[0.00605]      | -0.0187**<br>[0.00729]      |
| Urban Population 1700  | -0.0002<br>[0.0025]         | 0.0004<br>[0.0026]          | 0.0000<br>[0.0018]          | 0.0004<br>[0.0019]          |
| Alsace-Lorraine  |                             |                             | -0.0052<br>[0.00958]        | -0.0028<br>[0.0129]         |
| Observations   | 82                          | 82                          | 85                          | 85                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.00851***<br>[0.00245]    | -0.0113***<br>[0.00256]     | -0.00891***<br>[0.00243]    |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 12.012                      | 19.385                      | 13.445                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level,

\*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.6:** Industrialization and the evolution of fertility, accounting for market integration during the French Revolution

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.013**<br>[0.0053]        | -0.013**<br>[0.0055]        | -0.0107***<br>[0.0032]      | -0.0108***<br>[0.0033]      |
| Market Integration during the French Revolution                        |                             | 0.0084<br>[0.00734]         |                             | 0.0053<br>[0.00478]         |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0142**<br>[0.00719]       | -0.0046<br>[0.00570]        | -0.0055<br>[0.00533]        |
| Average Rainfall   | 0.0321<br>[0.0263]          | 0.0246<br>[0.0231]          | 0.0327*<br>[0.0178]         | 0.0279*<br>[0.0153]         |
| Average Temperature  | 0.0550<br>[0.0539]          | 0.0454<br>[0.0511]          | 0.0179<br>[0.0364]          | 0.0122<br>[0.0340]          |
| Average Latitude   | 1.247***<br>[0.236]         | 1.218***<br>[0.216]         | 0.794***<br>[0.183]         | 0.775***<br>[0.171]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0201<br>[0.0127]         | -0.0071<br>[0.0104]         | -0.0067<br>[0.0103]         |
| Maritime Department  | 0.0238***<br>[0.00870]      | 0.0219**<br>[0.00952]       | 0.0010<br>[0.00555]         | 0.00003<br>[0.00595]        |
| Distance to Paris  | 0.0001**<br>[4.76e-05]      | 0.0001**<br>[4.81e-05]      | 0.00003<br>[2.98e-05]       | 0.00003<br>[3.05e-05]       |
| Paris and Suburbs  | -0.0066<br>[0.0070]         | -0.0014<br>[0.0090]         | -0.0466***<br>[0.0116]      | -0.0434***<br>[0.0119]      |
| Fertility 1811   | -0.0112<br>[0.0299]         | 0.0073<br>[0.0293]          | -0.0704***<br>[0.0205]      | -0.0588***<br>[0.0195]      |
| University 1700  | -0.0114<br>[0.0078]         | -0.0127<br>[0.0079]         | -0.0139**<br>[0.0061]       | -0.0146**<br>[0.0060]       |
| Urban Population 1700  | -0.0002<br>[0.0025]         | -0.0024<br>[0.0023]         | 0.0000<br>[0.0018]          | -0.0014<br>[0.0017]         |
| Alsace-Lorraine  |                             |                             | -0.0052<br>[0.0096]         | -0.0037<br>[0.0101]         |
| Observations   | 82                          | 81                          | 85                          | 84                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.0109***<br>[0.00274]     | -0.0113***<br>[0.00256]     | -0.0112***<br>[0.00273]     |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 15.692                      | 19.385                      | 16.711                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.7:** Industrialization and the evolution of fertility, accounting for the railroad network in 1860

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]      | -0.0129**<br>[0.00542]      | -0.0107***<br>[0.00316]     | -0.0110***<br>[0.00321]     |
| Railroad Connection to Paris 1860                                      |                             | -0.0012<br>[0.0115]         |                             | 0.0059<br>[0.00736]         |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0157*<br>[0.00855]        | -0.0046<br>[0.00570]        | -0.0034<br>[0.00625]        |
| Average Rainfall   | 0.0321<br>[0.0263]          | 0.0325<br>[0.0262]          | 0.0327*<br>[0.0178]         | 0.0307*<br>[0.0182]         |
| Average Temperature  | 0.0550<br>[0.0539]          | 0.0547<br>[0.0545]          | 0.0179<br>[0.0364]          | 0.0195<br>[0.0371]          |
| Average Latitude   | 1.247***<br>[0.236]         | 1.239***<br>[0.272]         | 0.794***<br>[0.183]         | 0.837***<br>[0.202]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0202<br>[0.0166]         | -0.0071<br>[0.0104]         | -0.0114<br>[0.0127]         |
| Maritime Department  | 0.0238***<br>[0.00870]      | 0.0236**<br>[0.00917]       | 0.0010<br>[0.00555]         | 0.0023<br>[0.00596]         |
| Distance to Paris  | 0.0001**<br>[4.76e-05]      | 0.0001**<br>[4.88e-05]      | 0.00003<br>[2.98e-05]       | 0.00004<br>[3.14e-05]       |
| Paris and Suburbs  | -0.0066<br>[0.00702]        | -0.0067<br>[0.00716]        | -0.0466***<br>[0.0116]      | -0.0461***<br>[0.0115]      |
| Fertility 1811   | -0.0112<br>[0.0299]         | -0.0101<br>[0.0294]         | -0.0704***<br>[0.0205]      | -0.0755***<br>[0.0213]      |
| University 1700  | -0.0114<br>[0.00777]        | -0.0114<br>[0.00797]        | -0.0139**<br>[0.00605]      | -0.0142**<br>[0.00593]      |
| Urban Population 1700  | -0.0002<br>[0.00252]        | -0.0002<br>[0.00247]        | -0.00001<br>[0.00178]       | -0.00004<br>[0.00181]       |
| Alsace-Lorraine  |                             |                             | -0.0052<br>[0.00958]        | -0.0085<br>[0.0103]         |
| Observations   | 82                          | 82                          | 85                          | 85                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.0106***<br>[0.00249]     | -0.0113***<br>[0.00256]     | -0.0108***<br>[0.00252]     |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 18.092                      | 19.385                      | 18.476                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.8:** Industrialization and the evolution of fertility, accounting for the early concentration of the industrial sector

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]      | -0.0141**<br>[0.00604]      | -0.0107***<br>[0.00316]     | -0.0116***<br>[0.00343]     |
| Concentration Index  |                             | 0.0114<br>[0.0190]          |                             | 0.0050<br>[0.0136]          |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0154<br>[0.00999]         | -0.0046<br>[0.00570]        | -0.0034<br>[0.00674]        |
| Average Rainfall   | 0.0321<br>[0.0263]          | 0.0304<br>[0.0291]          | 0.0327*<br>[0.0178]         | 0.0308<br>[0.0193]          |
| Average Temperature  | 0.0550<br>[0.0539]          | 0.0524<br>[0.0781]          | 0.0179<br>[0.0364]          | 0.0246<br>[0.0486]          |
| Average Latitude   | 1.247***<br>[0.236]         | 1.279***<br>[0.294]         | 0.794***<br>[0.183]         | 0.836***<br>[0.217]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0215<br>[0.0136]         | -0.0071<br>[0.0104]         | -0.0082<br>[0.0113]         |
| Maritime Department  | 0.0238***<br>[0.00870]      | 0.0207**<br>[0.00933]       | 0.0010<br>[0.00555]         | -0.0015<br>[0.00624]        |
| Distance to Paris  | 0.0001**<br>[4.76e-05]      | 0.0001***<br>[4.56e-05]     | 0.00003<br>[2.98e-05]       | 0.00004<br>[2.93e-05]       |
| Paris and Suburbs  | -0.0066<br>[0.00702]        | -0.0034<br>[0.00816]        | -0.0466***<br>[0.0116]      | -0.0445***<br>[0.0114]      |
| Fertility 1811   | -0.0112<br>[0.0299]         | -0.0172<br>[0.0326]         | -0.0704***<br>[0.0205]      | -0.0794***<br>[0.0228]      |
| University 1700  | -0.0114<br>[0.00777]        | -0.0057<br>[0.00703]        | -0.0139**<br>[0.00605]      | -0.00913**<br>[0.00459]     |
| Urban Population 1700  | -0.0002<br>[0.00252]        | -0.0009<br>[0.00255]        | -0.00001<br>[0.00178]       | -0.0008<br>[0.00181]        |
| Alsace-Lorraine  |                             |                             | -0.0052<br>[0.00958]        | -0.0081<br>[0.0110]         |
| Observations   | 82                          | 78                          | 85                          | 81                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.0103***<br>[0.00246]     | -0.0113***<br>[0.00256]     | -0.0106***<br>[0.00247]     |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 17.467                      | 19.385                      | 18.345                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.9:** Industrialization and the evolution of fertility, accounting for population density in the 19<sup>th</sup> century

|  | (1)<br>IV               | (2)<br>IV               | (3)<br>IV               | (4)<br>IV               | (5)<br>IV               | (6)<br>IV               | (7)<br>IV               | (8)<br>IV               |
|--|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|  | Fertility 1911          |                         |                         | Fertility 1931          |                         |                         |                         |                         |
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]  | -0.0120**<br>[0.00526]  | -0.0127**<br>[0.00528]  | -0.0126**<br>[0.00536]  | -0.0106***<br>[0.00311] | -0.0106***<br>[0.00311] | -0.0105***<br>[0.00313] | -0.0104***<br>[0.00318] |
| Population Density 1801  |                         | -0.0129*<br>[0.00670]   |                         |                         | -0.0095**<br>[0.00472]  | -0.0095**<br>[0.00472]  |                         |                         |
| Population Density 1831  |                         |                         | -0.0095<br>[0.00673]    |                         |                         |                         | -0.0070<br>[0.00467]    |                         |
| Population Density 1861  |                         |                         |                         | -0.0061<br>[0.00660]    |                         |                         |                         | -0.0051<br>[0.00454]    |
| Average Altitude   | 0.0159**<br>[0.00785]   | 0.0161**<br>[0.00772]   | 0.0160**<br>[0.00780]   | 0.0158**<br>[0.00785]   | -0.0043<br>[0.00557]    | -0.0043<br>[0.00557]    | -0.0045<br>[0.00562]    | -0.0047<br>[0.00565]    |
| Average Rainfall   | 0.0321<br>[0.0263]      | 0.0340<br>[0.0259]      | 0.0332<br>[0.0259]      | 0.0325<br>[0.0259]      | 0.0343**<br>[0.0173]    | 0.0343**<br>[0.0173]    | 0.0337*<br>[0.0173]     | 0.0332*<br>[0.0173]     |
| Average Temperature  | 0.0550<br>[0.0539]      | 0.0588<br>[0.0529]      | 0.0568<br>[0.0532]      | 0.0551<br>[0.0534]      | 0.0207<br>[0.0354]      | 0.0207<br>[0.0354]      | 0.0189<br>[0.0357]      | 0.0177<br>[0.0358]      |
| Average Latitude   | 1.247***<br>[0.236]     | 1.278***<br>[0.230]     | 1.270***<br>[0.229]     | 1.259***<br>[0.230]     | 0.815***<br>[0.177]     | 0.815***<br>[0.177]     | 0.809***<br>[0.177]     | 0.802***<br>[0.176]     |
| Average Land Suitability   | -0.0211*<br>[0.0127]    | -0.0216*<br>[0.0125]    | -0.0214*<br>[0.0125]    | -0.0212*<br>[0.0125]    | -0.0075<br>[0.0102]     | -0.0075<br>[0.0102]     | -0.0073<br>[0.0102]     | -0.0071<br>[0.0102]     |
| Maritime Department  | 0.0238***<br>[0.00870]  | 0.0232***<br>[0.00893]  | 0.0234***<br>[0.00850]  | 0.0234***<br>[0.00853]  | 0.0008<br>[0.00568]     | 0.0008<br>[0.00568]     | 0.0007<br>[0.00539]     | 0.0007<br>[0.00538]     |
| Distance to Paris  | 0.0001**<br>[4.76e-05]  | 0.0001**<br>[4.69e-05]  | 0.0001**<br>[4.56e-05]  | 0.0001**<br>[4.61e-05]  | 0.00003<br>[2.92e-05]   | 0.00003<br>[2.92e-05]   | 0.00003<br>[2.84e-05]   | 0.00003<br>[2.85e-05]   |
| Paris and Suburbs  | -0.0066<br>[0.00702]    | 0.0021<br>[0.00955]     | 0.0008<br>[0.00938]     | -0.0005<br>[0.00961]    | -0.0402***<br>[0.0136]  | -0.0402***<br>[0.0136]  | -0.0412***<br>[0.0137]  | -0.0415***<br>[0.0142]  |
| Fertility 1811   | -0.0112<br>[0.0299]     | -0.0132<br>[0.0298]     | -0.0116<br>[0.0294]     | -0.0101<br>[0.0296]     | -0.0716***<br>[0.0205]  | -0.0716***<br>[0.0205]  | -0.0706***<br>[0.0203]  | -0.0695***<br>[0.0203]  |
| University 1700  | -0.0114<br>[0.00777]    | -0.0102<br>[0.00770]    | -0.0103<br>[0.00777]    | -0.0105<br>[0.00784]    | -0.0128**<br>[0.00588]  | -0.0128**<br>[0.00588]  | -0.0131**<br>[0.00598]  | -0.0131**<br>[0.00597]  |
| Urban Population 1700  | -0.0002<br>[0.00252]    | 0.0002<br>[0.00252]     | 0.0001<br>[0.00246]     | 0.0001<br>[0.00244]     | 0.0003<br>[0.00175]     | 0.0003<br>[0.00175]     | 0.0002<br>[0.00171]     | 0.0002<br>[0.00171]     |
| Alsace-Lorraine  |                         |                         |                         |                         | -0.0052<br>[0.0091]     | -0.0052<br>[0.0091]     | -0.0053<br>[0.0091]     | -0.0055<br>[0.0092]     |
| Observations   | 82                      | 81                      | 82                      | 82                      | 84                      | 84                      | 85                      | 85                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                         |                         |                         |                         |                         |                         |                         |                         |
| Distance to Fresnes  | -0.0110***<br>[0.00257] | -0.0109***<br>[0.00258] | -0.0109***<br>[0.00258] | -0.0108***<br>[0.00256] | -0.0113***<br>[0.00256] | -0.0112***<br>[0.00256] | -0.0112***<br>[0.00255] | -0.0110***<br>[0.00253] |
| F-stat (1 <sup>st</sup> stage)   | 18.218                  | 18.008                  | 17.895                  | 17.660                  | 19.183                  | 19.183                  | 19.062                  | 18.764                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.10:** Industrialization and the evolution of fertility, accounting for the share of Catholics in 1861

|  | (1)<br>IV<br>Fertility 1911 | (2)<br>IV<br>Fertility 1911 | (3)<br>IV<br>Fertility 1931 | (4)<br>IV<br>Fertility 1931 |
|--|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.0053]       | -0.0135**<br>[0.0053]       | -0.0107***<br>[0.0032]      | -0.0107***<br>[0.0032]      |
| Share of Catholics 1861  |                             | -0.169*<br>[0.0937]         |                             | -0.0155<br>[0.0305]         |
| Average Altitude   | 0.0159**<br>[0.00785]       | 0.0165**<br>[0.00764]       | -0.005<br>[0.00570]         | -0.005<br>[0.00567]         |
| Average Rainfall   | 0.032<br>[0.0263]           | 0.022<br>[0.0264]           | 0.0327*<br>[0.0178]         | 0.0315*<br>[0.0177]         |
| Average Temperature  | 0.055<br>[0.0539]           | 0.059<br>[0.0539]           | 0.018<br>[0.0364]           | 0.018<br>[0.0363]           |
| Average Latitude   | 1.247***<br>[0.236]         | 1.303***<br>[0.236]         | 0.794***<br>[0.183]         | 0.794***<br>[0.183]         |
| Average Land Suitability   | -0.0211*<br>[0.0127]        | -0.0221*<br>[0.0114]        | -0.007<br>[0.0104]          | -0.007<br>[0.0104]          |
| Maritime Department  | 0.0238***<br>[0.00870]      | 0.0230***<br>[0.00874]      | 0.001<br>[0.00555]          | 0.001<br>[0.00554]          |
| Distance to Paris  | 0.000104**<br>[4.76e-05]    | 0.000102**<br>[4.65e-05]    | 0.000<br>[2.98e-05]         | 0.000<br>[2.97e-05]         |
| Paris and Suburbs  | -0.007<br>[0.00702]         | -0.009<br>[0.00662]         | -0.0466***<br>[0.0116]      | -0.0470***<br>[0.0115]      |
| Fertility 1811   | -0.011<br>[0.0299]          | 0.002<br>[0.0269]           | -0.0704***<br>[0.0205]      | -0.0695***<br>[0.0208]      |
| University 1700  | -0.011<br>[0.00777]         | -0.009<br>[0.00778]         | -0.0139**<br>[0.00605]      | -0.0139**<br>[0.00601]      |
| Urban Population 1700  | -0.0002<br>[0.00252]        | -0.001<br>[0.00237]         | -0.00001<br>[0.00178]       | -0.00009<br>[0.00175]       |
| Alsace-Lorraine  |                             |                             | -0.005<br>[0.00958]         | -0.007<br>[0.0114]          |
|  | 82                          | 82                          | 85                          | 85                          |
| First stage: the instrumented variable is Horse Power of Steam Engines |                             |                             |                             |                             |
| Distance to Fresnes  | -0.0110***<br>[0.00257]     | -0.0108***<br>[0.00250]     | -0.0113***<br>[0.00256]     | -0.0113***<br>[0.00257]     |
| F-stat (1 <sup>st</sup> stage)   | 18.218                      | 18.476                      | 19.385                      | 19.417                      |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.11:** Industrialization and the evolution of fertility, accounting for the share of grooms who signed their marriage license before 1820

|  | (1)<br>IV                | (2)<br>IV<br>Fertility 1911 | (3)<br>IV                | (4)<br>IV                | (5)<br>IV               | (6)<br>IV<br>Fertility 1931 | (7)<br>IV               | (8)<br>IV               |
|--|--------------------------|-----------------------------|--------------------------|--------------------------|-------------------------|-----------------------------|-------------------------|-------------------------|
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]   | -0.0125**<br>[0.00547]      | -0.0144**<br>[0.00618]   | -0.0106*<br>[0.00603]    | -0.0107***<br>[0.00316] | -0.0117***<br>[0.00325]     | -0.0113***<br>[0.00346] | -0.0101***<br>[0.00353] |
| Share of Literate Grooms 1686-1690                                     |                          | 0.0035<br>[0.0208]          |                          |                          |                         | 0.0158<br>[0.0177]          |                         |                         |
| Share of Literate Grooms 1786-1790                                     |                          |                             | 0.0033<br>[0.0188]       |                          |                         |                             | -0.0072<br>[0.0112]     |                         |
| Share of Literate Grooms 1816-1820                                     |                          |                             |                          | -0.0308*<br>[0.0181]     |                         |                             |                         | -0.0088<br>[0.0130]     |
| Average Altitude   | 0.0159**<br>[0.00785]    | 0.0168**<br>[0.00821]       | 0.0190**<br>[0.00905]    | 0.0156*<br>[0.00853]     | -0.0046<br>[0.00570]    | -0.0014<br>[0.00544]        | -0.0023<br>[0.00576]    | -0.0034<br>[0.00568]    |
| Average Rainfall   | 0.0321<br>[0.0263]       | 0.0255<br>[0.0264]          | 0.0386<br>[0.0309]       | 0.0420<br>[0.0277]       | 0.0327*<br>[0.0178]     | 0.0375**<br>[0.0169]        | 0.0448**<br>[0.0196]    | 0.0428**<br>[0.0188]    |
| Average Temperature  | 0.0550<br>[0.0539]       | 0.0733<br>[0.0644]          | 0.0810<br>[0.0694]       | 0.0223<br>[0.0666]       | 0.0179<br>[0.0364]      | 0.0540<br>[0.0394]          | 0.0297<br>[0.0386]      | 0.0174<br>[0.0388]      |
| Average Latitude   | 1.247***<br>[0.236]      | 1.361***<br>[0.248]         | 1.359***<br>[0.275]      | 1.255***<br>[0.290]      | 0.794***<br>[0.183]     | 0.948***<br>[0.197]         | 0.909***<br>[0.197]     | 0.837***<br>[0.195]     |
| Average Land Suitability   | -0.0211*<br>[0.0127]     | -0.0191<br>[0.0127]         | -0.0247<br>[0.0154]      | -0.0103<br>[0.0139]      | -0.0071<br>[0.0104]     | -0.0131<br>[0.0111]         | -0.0068<br>[0.0104]     | -0.0046<br>[0.0104]     |
| Maritime Department  | 0.0238***<br>[0.00870]   | 0.0192**<br>[0.00901]       | 0.0208**<br>[0.00928]    | 0.0230***<br>[0.00850]   | 0.0010<br>[0.00555]     | -0.0058<br>[0.00547]        | -0.0033<br>[0.00528]    | -0.0034<br>[0.00505]    |
| Distance to Paris  | 0.000104**<br>[4.76e-05] | 0.000128***<br>[4.33e-05]   | 0.000114**<br>[4.75e-05] | 0.000120**<br>[4.71e-05] | 0.0000<br>[2.98e-05]    | 5.31e-05*<br>[2.98e-05]     | 0.0000<br>[3.01e-05]    | 0.0000<br>[2.87e-05]    |
| Paris and Suburbs  | -0.0066<br>[0.00702]     | -0.0072<br>[0.00737]        | -0.0077<br>[0.00801]     | -0.0006<br>[0.00824]     | -0.0466***<br>[0.0116]  | -0.0453***<br>[0.0162]      | -0.0416***<br>[0.0158]  | -0.0418***<br>[0.0154]  |
| Fertility 1811   | -0.0112<br>[0.0299]      | 0.0009<br>[0.0291]          | -0.0250<br>[0.0373]      | -0.0453<br>[0.0350]      | -0.0704***<br>[0.0205]  | -0.0755***<br>[0.0215]      | -0.0905***<br>[0.0227]  | -0.0942***<br>[0.0215]  |
| University 1700  | -0.0114<br>[0.00777]     | -0.0046<br>[0.00687]        | -0.0039<br>[0.00742]     | -0.0064<br>[0.00670]     | -0.0139**<br>[0.00605]  | -0.0054<br>[0.00443]        | -0.0064<br>[0.00436]    | -0.0063<br>[0.00413]    |
| Urban Population 1700  | -0.0002<br>[0.00252]     | -0.0004<br>[0.00258]        | -0.0003<br>[0.00273]     | -0.0017<br>[0.00259]     | 0.0000<br>[0.00178]     | 0.0006<br>[0.00185]         | 0.0000<br>[0.00185]     | -0.0005<br>[0.00180]    |
| Alsace-Lorraine  |                          |                             |                          |                          | -0.0052<br>[0.00958]    | 0.0058<br>[0.00763]         | 0.0116*<br>[0.00702]    | 0.0129*<br>[0.00663]    |
| Observations   | 82                       | 75                          | 78                       | 77                       | 85                      | 76                          | 79                      | 78                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                          |                             |                          |                          |                         |                             |                         |                         |
| Distance to Fresnes  | -0.0110***<br>[0.00257]  | -0.0110***<br>[0.00236]     | -0.0108***<br>[0.00234]  | -0.0104***<br>[0.00241]  | -0.0113***<br>[0.00256] | -0.0110***<br>[0.00237]     | -0.0108***<br>[0.00236] | -0.0104***<br>[0.00243] |
| F-stat (1 <sup>st</sup> stage)   | 18.218                   | 21.652                      | 21.359                   | 18.783                   | 19.385                  | 21.367                      | 21.088                  | 18.542                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.12:** Industrialization and the evolution of fertility, accounting for contemporaneous measures of human capital and economic development, 1871

|  | (1)                     | (2)                     | (3)                     | (4)                    | (5)                       | (6)                     |
|--|-------------------------|-------------------------|-------------------------|------------------------|---------------------------|-------------------------|
|  | IV                      | IV                      | IV                      | IV                     | IV                        | IV                      |
|  | Fertility 1871          |                         |                         |                        |                           |                         |
| Horse Power of Steam Engines   | -0.0075<br>[0.0127]     | -0.0052<br>[0.0118]     | -0.0056<br>[0.0139]     | 0.0091<br>[0.0105]     | 0.0009<br>[0.0101]        | 0.0130<br>[0.0103]      |
| High-School Graduates 1872   |                         | -2.225**<br>[0.983]     |                         |                        |                           | -1.3000<br>[0.812]      |
| GDP per capita 1872  |                         |                         | -0.0183<br>[0.0304]     |                        |                           | -0.0269<br>[0.0269]     |
| Mortality Age 0-1 1871   |                         |                         |                         | 0.477***<br>[0.0842]   |                           | 0.1390<br>[0.144]       |
| Life Expectancy Age 15 1911  |                         |                         |                         |                        | -0.00733***<br>[0.00252]  | -0.0112***<br>[0.00412] |
| Average Altitude   | 0.0197<br>[0.0144]      | 0.0151<br>[0.0131]      | 0.0167<br>[0.0161]      | 0.0173<br>[0.0137]     | 0.0233*<br>[0.0127]       | 0.0150<br>[0.0153]      |
| Average Rainfall   | -0.0108<br>[0.0465]     | -0.0122<br>[0.0436]     | -0.0177<br>[0.0492]     | -0.0959***<br>[0.0353] | -0.0482<br>[0.0359]       | -0.108***<br>[0.0393]   |
| Average Temperature  | -0.0099<br>[0.107]      | -0.0651<br>[0.0991]     | -0.0248<br>[0.113]      | -0.0269<br>[0.0945]    | -0.0036<br>[0.0905]       | -0.0683<br>[0.0935]     |
| Average Latitude   | 0.909*<br>[0.502]       | 0.6700<br>[0.484]       | 0.7880<br>[0.568]       | 0.3650<br>[0.453]      | 0.932**<br>[0.430]        | 0.0282<br>[0.502]       |
| Average Land Suitability   | -0.0539**<br>[0.0233]   | -0.0404*<br>[0.0228]    | -0.0508**<br>[0.0231]   | -0.0507**<br>[0.0219]  | -0.0568***<br>[0.0209]    | -0.0459*<br>[0.0259]    |
| Maritime Department  | 0.0424***<br>[0.0131]   | 0.0515***<br>[0.0140]   | 0.0437***<br>[0.0126]   | 0.0273**<br>[0.0119]   | 0.0291***<br>[0.0105]     | 0.0392***<br>[0.0107]   |
| Distance to Paris  | 0.000169*<br>[9.07e-05] | 0.000154*<br>[8.69e-05] | 0.000152*<br>[8.81e-05] | 0.0001<br>[7.95e-05]   | 0.000203***<br>[7.51e-05] | 0.0001<br>[7.16e-05]    |
| Paris and Suburbs  | 0.0355<br>[0.0318]      | 0.0349<br>[0.0318]      | 0.0358<br>[0.0312]      | 0.0058<br>[0.0372]     | 0.0101<br>[0.0285]        | -0.0188<br>[0.0285]     |
| Fertility 1811   | 0.225***<br>[0.0483]    | 0.236***<br>[0.0439]    | 0.215***<br>[0.0474]    | 0.0769<br>[0.0536]     | 0.139***<br>[0.0528]      | 0.0505<br>[0.0533]      |
| University 1700  | -0.00003<br>[0.0132]    | 0.0016<br>[0.0126]      | -0.0016<br>[0.0120]     | 0.0039<br>[0.0108]     | -0.0005<br>[0.0101]       | -0.0010<br>[0.0107]     |
| Urban Population 1700  | -0.0027<br>[0.0056]     | -0.0041<br>[0.0051]     | -0.0027<br>[0.0054]     | -0.0114**<br>[0.0049]  | -0.0048<br>[0.0047]       | -0.0112**<br>[0.0044]   |
| Observations   | 82                      | 82                      | 82                      | 81                     | 82                        | 81                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                         |                         |                         |                        |                           |                         |
| Distance to Fresnes  | -0.0110***<br>[0.0026]  | -0.0113***<br>[0.0026]  | -0.0102***<br>[0.0025]  | -0.0123***<br>[0.0034] | -0.0120***<br>[0.0029]    | -0.0117***<br>[0.0034]  |
| F-stat (1 <sup>st</sup> stage)   | 18.218                  | 18.739                  | 16.906                  | 13.125                 | 17.449                    | 11.962                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.



**Table B.13:** Industrialization and the evolution of fertility, accounting for contemporaneous measures of human capital and economic development, 1891

|  | (1)                      | (2)                      | (3)                      | (4)                     | (5)                      | (6)                      | (7)                     |
|--|--------------------------|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|-------------------------|
|  | IV                       | IV                       | IV                       | IV                      | IV                       | IV                       | IV                      |
|  | Fertility 1891           |                          |                          |                         |                          |                          |                         |
| Horse Power of Steam Engines   | -0.010<br>[0.00896]      | -0.008<br>[0.00841]      | -0.008<br>[0.00871]      | 0.001<br>[0.00594]      | -0.009<br>[0.0086]       | -0.001<br>[0.00692]      | 0.003<br>[0.00558]      |
| High-School Graduates 1892   |                          | -0.755<br>[0.564]        |                          |                         |                          |                          | -0.638<br>[0.494]       |
| GDP per capita 1886  |                          |                          | -0.016<br>[0.0157]       |                         |                          |                          | -0.019<br>[0.0142]      |
| Mortality Age 0-1 1891   |                          |                          |                          | 0.330***<br>[0.121]     |                          |                          | 0.062<br>[0.209]        |
| Male to Female Wage Ratio 1891   |                          |                          |                          |                         | -0.0287*<br>[0.0173]     |                          | -0.0251*<br>[0.0140]    |
| Life Expectancy Age 15 1891  |                          |                          |                          |                         |                          | -0.00826***<br>[0.00243] | -0.006<br>[0.00419]     |
| Average Altitude   | 0.019<br>[0.0141]        | 0.018<br>[0.0133]        | 0.013<br>[0.0146]        | 0.010<br>[0.0104]       | 0.007<br>[0.0141]        | 0.010<br>[0.0111]        | -0.001<br>[0.0109]      |
| Average Rainfall   | -0.014<br>[0.0340]       | -0.014<br>[0.0320]       | -0.016<br>[0.0322]       | -0.030<br>[0.0249]      | -0.032<br>[0.0340]       | -0.020<br>[0.0261]       | -0.028<br>[0.0236]      |
| Average Temperature  | -0.018<br>[0.0947]       | -0.038<br>[0.0912]       | -0.054<br>[0.0960]       | -0.037<br>[0.0815]      | -0.055<br>[0.0947]       | -0.035<br>[0.0832]       | -0.099<br>[0.0857]      |
| Average Latitude   | 1.212**<br>[0.521]       | 1.127**<br>[0.519]       | 1.096**<br>[0.493]       | 0.493<br>[0.374]        | 1.212**<br>[0.521]       | 0.577<br>[0.385]         | 0.309<br>[0.363]        |
| Average Land Suitability   | -0.014<br>[0.0249]       | -0.008<br>[0.0240]       | -0.006<br>[0.0238]       | -0.014<br>[0.0213]      | -0.010<br>[0.0249]       | -0.015<br>[0.0220]       | 0.003<br>[0.0207]       |
| Maritime Department  | 0.0472***<br>[0.0119]    | 0.0457***<br>[0.0123]    | 0.0458***<br>[0.0116]    | 0.0404***<br>[0.0123]   | 0.0472***<br>[0.0119]    | 0.0420***<br>[0.0110]    | 0.0421***<br>[0.0114]   |
| Distance to Paris  | 0.000159**<br>[7.51e-05] | 0.000162**<br>[7.46e-05] | 0.000162**<br>[7.10e-05] | 0.000<br>[8.38e-05]     | 0.000159**<br>[7.51e-05] | 0.000<br>[6.77e-05]      | 0.000<br>[7.49e-05]     |
| Paris and Suburbs  | 0.0608***<br>[0.0195]    | 0.0703***<br>[0.0222]    | 0.0633***<br>[0.0206]    | 0.026<br>[0.0188]       | 0.0608***<br>[0.0195]    | 0.015<br>[0.0207]        | 0.0455**<br>[0.0229]    |
| Fertility 1811   | 0.133***<br>[0.0440]     | 0.129***<br>[0.0430]     | 0.143***<br>[0.0379]     | 0.0977**<br>[0.0444]    | 0.133***<br>[0.0440]     | 0.0953**<br>[0.0430]     | 0.114***<br>[0.0394]    |
| University 1700  | -0.010<br>[0.00930]      | -0.009<br>[0.00929]      | -0.012<br>[0.00914]      | -0.008<br>[0.00758]     | -0.008<br>[0.00930]      | -0.007<br>[0.00808]      | -0.010<br>[0.00896]     |
| Urban Population 1700  | 0.000<br>[0.00421]       | 0.000<br>[0.00410]       | 0.000<br>[0.00407]       | -0.00611**<br>[0.00303] | 0.000<br>[0.00421]       | -0.004<br>[0.00322]      | -0.00541**<br>[0.00269] |
| Observations   | 82                       | 82                       | 82                       | 81                      | 82                       | 82                       | 81                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                          |                          |                          |                         |                          |                          |                         |
| Distance to Fresnes  | -0.0110***<br>[0.00257]  | -0.0112***<br>[0.00257]  | -0.0107***<br>[0.00266]  | -0.0163***<br>[0.00307] | -0.0110***<br>[0.00257]  | -0.0136***<br>[0.00319]  | -0.0160***<br>[0.00341] |
| F-stat (1 <sup>st</sup> stage)   | 18.218                   | 18.857                   | 16.205                   | 28.147                  | 18.1496                  | 18.143                   | 21.864                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level,

\*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.14:** Industrialization and the evolution of fertility, accounting for contemporaneous measures of human capital and economic development, 1911

|  | (1)                      | (2)                       | (3)                      | (4)                     | (5)                     | (6)                     | (7)                     |
|--|--------------------------|---------------------------|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|  | IV                       | IV                        | IV                       | IV                      | IV                      | IV                      | IV                      |
|  | Fertility 1911           |                           |                          |                         |                         |                         |                         |
| Horse Power of Steam Engines   | -0.0130**<br>[0.00528]   | -0.0109**<br>[0.00445]    | -0.0114**<br>[0.00516]   | -0.0116**<br>[0.00471]  | -0.0127**<br>[0.00532]  | -0.0125**<br>[0.00548]  | -0.0110**<br>[0.00466]  |
| High-School Graduates 1911   |                          | -1.426***<br>[0.420]      |                          |                         |                         |                         | -1.142***<br>[0.418]    |
| GDP per capita 1911  |                          |                           | -0.009<br>[0.0103]       |                         |                         |                         | 0.00544<br>[0.00967]    |
| Mortality Age 0-1 1911   |                          |                           |                          | 1.295***<br>[0.401]     |                         |                         | 1.113***<br>[0.374]     |
| Male to Female Wage Ratio 1911   |                          |                           |                          |                         | -0.012<br>[0.00724]     |                         | 0.0009<br>[0.00492]     |
| Life Expectancy Age 15 1911  |                          |                           |                          |                         |                         | -0.0009<br>[0.0008]     | -0.00007<br>[0.0008]    |
| Average Altitude   | 0.0159**<br>[0.00785]    | 0.00997<br>[0.00644]      | 0.0149**<br>[0.00741]    | 0.00819<br>[0.00625]    | 0.0167**<br>[0.00765]   | 0.0150*<br>[0.00817]    | 0.005<br>[0.00589]      |
| Average Rainfall   | 0.032<br>[0.0263]        | 0.0517**<br>[0.0247]      | 0.027<br>[0.0251]        | 0.0525*<br>[0.0271]     | 0.027<br>[0.0260]       | 0.031<br>[0.0261]       | 0.0734**<br>[0.0318]    |
| Average Temperature  | 0.055<br>[0.0539]        | 0.028<br>[0.0452]         | 0.038<br>[0.0536]        | 0.086<br>[0.0550]       | 0.060<br>[0.0561]       | 0.051<br>[0.0553]       | 0.072<br>[0.0535]       |
| Average Latitude   | 1.247***<br>[0.236]      | 1.152***<br>[0.207]       | 1.204***<br>[0.233]      | 0.960***<br>[0.203]     | 1.216***<br>[0.217]     | 1.172***<br>[0.275]     | 0.958***<br>[0.214]     |
| Average Land Suitability   | -0.0211*<br>[0.0127]     | -0.007<br>[0.0110]        | -0.017<br>[0.0121]       | -0.0228**<br>[0.0101]   | -0.0259*<br>[0.0136]    | -0.0209*<br>[0.0126]    | -0.015<br>[0.0102]      |
| Maritime Department  | 0.0238***<br>[0.00870]   | 0.0148*<br>[0.00804]      | 0.0241***<br>[0.00849]   | 0.0163**<br>[0.00831]   | 0.0257***<br>[0.00851]  | 0.0246***<br>[0.00870]  | 0.010<br>[0.00912]      |
| Distance to Paris  | 0.000104**<br>[4.76e-05] | 0.000138***<br>[4.04e-05] | 0.000106**<br>[4.60e-05] | 0.00004<br>[4.38e-05]   | 9.08e-05*<br>[5.42e-05] | 9.16e-05*<br>[4.92e-05] | 7.49e-05*<br>[4.10e-05] |
| Paris and Suburbs  | -0.007<br>[0.00702]      | 0.0192*<br>[0.0109]       | -0.006<br>[0.00699]      | -0.0228***<br>[0.00769] | -0.012<br>[0.00863]     | -0.009<br>[0.00779]     | 0.002<br>[0.00991]      |
| Fertility 1811   | -0.011<br>[0.0299]       | -0.010<br>[0.0239]        | -0.017<br>[0.0312]       | 0.0399*<br>[0.0209]     | -0.009<br>[0.0278]      | -0.010<br>[0.0295]      | 0.0366*<br>[0.0203]     |
| University 1700  | -0.011<br>[0.00777]      | -0.009<br>[0.00861]       | -0.011<br>[0.00740]      | -0.008<br>[0.00901]     | -0.009<br>[0.00871]     | -0.011<br>[0.00761]     | -0.008<br>[0.0102]      |
| Urban Population 1700  | 0.000<br>[0.00252]       | 0.002<br>[0.00228]        | 0.000<br>[0.00246]       | -0.003<br>[0.00234]     | 0.000<br>[0.00252]      | -0.001<br>[0.00268]     | -0.001<br>[0.00236]     |
| Observations   | 82                       | 82                        | 82                       | 82                      | 78                      | 82                      | 78                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                          |                           |                          |                         |                         |                         |                         |
| Distance to Fresnes  | -0.0110***<br>[0.00257]  | -0.0115***<br>[0.00261]   | -0.0112***<br>[0.00285]  | -0.0112***<br>[0.00250] | -0.0110***<br>[0.00260] | -0.0104***<br>[0.00268] | -0.0102***<br>[0.00309] |
| F-stat ( <i>1<sup>st</sup></i> stage)                                  | 18.218                   | 19.433                    | 15.500                   | 19.993                  | 17.950                  | 15.138                  | 10.871                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.15:** Industrialization and the evolution of fertility, accounting for contemporaneous measures of human capital and economic development, 1931

|  | (1)<br>IV              | (2)<br>IV<br>Fertility 1931 | (3)<br>IV             | (4)<br>IV             |
|--|------------------------|-----------------------------|-----------------------|-----------------------|
| Horse Power of Steam Engines   | -0.0107***<br>[0.0032] | -0.00832**<br>[0.0035]      | -0.0206<br>[0.0290]   | -0.0082<br>[0.0164]   |
| High-School Graduates 1931   |                        | -0.325*<br>[0.196]          |                       | -0.390**<br>[0.165]   |
| GDP per capita 1930  |                        |                             | 0.0626<br>[0.174]     | 0.0007<br>[0.0960]    |
| Average Altitude   | -0.0046<br>[0.00570]   | -0.0069<br>[0.00541]        | -0.0001<br>[0.0182]   | -0.0079<br>[0.0102]   |
| Average Rainfall   | 0.0327*<br>[0.0178]    | 0.0318**<br>[0.0156]        | 0.0576<br>[0.0740]    | 0.0347<br>[0.0437]    |
| Average Temperature  | 0.0179<br>[0.0364]     | -0.0061<br>[0.0378]         | 0.0920<br>[0.234]     | -0.0112<br>[0.132]    |
| Average Latitude   | 0.794***<br>[0.183]    | 0.726***<br>[0.172]         | 1.0800<br>[0.904]     | 0.7210<br>[0.506]     |
| Average Land Suitability   | -0.0071<br>[0.0104]    | -0.0010<br>[0.0101]         | -0.0287<br>[0.0699]   | 0.0015<br>[0.0381]    |
| Maritime Department  | 0.0010<br>[0.00555]    | -0.0003<br>[0.00503]        | 0.0034<br>[0.0127]    | -0.0009<br>[0.00665]  |
| Distance to Paris  | 0.00003<br>[2.98e-05]  | 0.0001<br>[3.08e-05]        | 0.00002<br>[5.96e-05] | 0.0001<br>[3.49e-05]  |
| Paris and Suburbs  | -0.0466***<br>[0.0116] | -0.0368***<br>[0.0114]      | -0.0613<br>[0.0451]   | -0.0342<br>[0.0246]   |
| Fertility 1811   | -0.0704***<br>[0.0205] | -0.0703***<br>[0.0183]      | -0.0801*<br>[0.0482]  | -0.0680**<br>[0.0268] |
| University 1700  | -0.0139**<br>[0.00605] | -0.0135***<br>[0.00514]     | -0.0198<br>[0.0233]   | -0.0124<br>[0.0128]   |
| Urban Population 1700  | -0.00001<br>[0.00178]  | -0.0004<br>[0.00166]        | 0.0002<br>[0.00312]   | -0.0006<br>[0.00181]  |
| Alsace-Lorraine  | -0.0052<br>[0.00958]   | -0.0022<br>[0.0109]         | -0.0154<br>[0.0121]   | -0.0129*<br>[0.00712] |
| Observations   | 85                     | 85                          | 84                    | 84                    |
| First stage: the instrumented variable is Horse Power of Steam Engines |                        |                             |                       |                       |
| Distance to Fresnes  | -0.0113***<br>[0.0026] | -0.0110***<br>[0.0030]      | -0.0023<br>[0.0031]   | -0.0028<br>[0.0033]   |
| F-stat (1 <sup>st</sup> stage)   | 19.385                 | 13.304                      | 0.530                 | 0.715                 |

Note: The post-WW1 regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

**Table B.16:** Industrialization and the evolution of fertility, accounting for building destruction and military casualties during World War I

|  | (1)                     | (2)                     | (3)                     |
|--|-------------------------|-------------------------|-------------------------|
|  | IV                      | IV                      | IV                      |
|  | Fertility 1931          |                         |                         |
| Horse Power of Steam Engines   | -0.0107***<br>[0.00316] | -0.0107***<br>[0.00361] | -0.0108***<br>[0.00326] |
| Destroyed Buildings WWI  |                         | 0.000004<br>[0.0006]    |                         |
| Soldier deaths in World War I  |                         |                         | 0.008<br>[0.0091]       |
| Average Altitude   | -0.005<br>[0.0057]      | -0.005<br>[0.0058]      | -0.005<br>[0.0057]      |
| Average Rainfall   | 0.0327*<br>[0.0178]     | 0.0328*<br>[0.0186]     | 0.026<br>[0.0166]       |
| Average Temperature  | 0.018<br>[0.0364]       | 0.018<br>[0.0373]       | 0.007<br>[0.0318]       |
| Average Latitude   | 0.794***<br>[0.183]     | 0.794***<br>[0.176]     | 0.717***<br>[0.166]     |
| Average Land Suitability   | -0.007<br>[0.0104]      | -0.007<br>[0.0104]      | -0.003<br>[0.010]       |
| Maritime Department  | 0.001<br>[0.0056]       | 0.001<br>[0.0057]       | -0.001<br>[0.0058]      |
| Distance to Paris  | 0.00003<br>[2.98e-05]   | 0.00003<br>[3.28e-05]   | 0.00003<br>[3.10e-05]   |
| Paris and Suburbs  | -0.0466***<br>[0.0116]  | -0.0466***<br>[0.0117]  | -0.0522***<br>[0.0138]  |
| Fertility 1811   | -0.0704***<br>[0.0205]  | -0.0705***<br>[0.0208]  | -0.0737***<br>[0.0221]  |
| University 1700  | -0.0139**<br>[0.00605]  | -0.0139**<br>[0.00601]  | -0.0152**<br>[0.00646]  |
| Urban Population 1700  | -0.00001<br>[0.00178]   | -0.000001<br>[0.00172]  | -0.0005<br>[0.00165]    |
| Alsace-Lorraine  | -0.005<br>[0.00958]     | -0.005<br>[0.0110]      | 0.016<br>[0.0269]       |
| Observations   | 85                      | 85                      | 85                      |
| First stage: the instrumented variable is Horse Power of Steam Engines |                         |                         |                         |
| Distance to Fresnes  | -0.0113***<br>[0.00256] | -0.0181***<br>[0.00546] | -0.0112***<br>[0.00286] |
| F-stat (1 <sup>st</sup> stage)   | 19.385                  | 11.024                  | 15.294                  |

Note: The aerial distances are measured in kilometers. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

## Appendix C. Spatial regressions

**Table C.1:** Industrialization, education and fertility in the 1871–1931 period, accounting for spatial autocorrelation

|                              | (1)<br>OLS           | (2)<br>OLS             | (3)<br>IV              | (4)<br>OLS           | (5)<br>OLS              | (6)<br>IV               | (7)<br>OLS           | (8)<br>OLS               | (9)<br>IV             | (10)<br>OLS          | (11)<br>OLS              | (12)<br>IV               |
|------------------------------|----------------------|------------------------|------------------------|----------------------|-------------------------|-------------------------|----------------------|--------------------------|-----------------------|----------------------|--------------------------|--------------------------|
|                              | Fertility 1871       |                        |                        | Fertility 1891       |                         |                         | Fertility 1911       |                          |                       | Fertility 1931       |                          |                          |
| Horse Power of Steam Engines | 0.042<br>[0.0003]*** | 0.003<br>[0.0003]***   | 0.003<br>[0.001]***    | 0.037<br>[0.0002]*** | 0.002<br>[0.0002]***    | 0.004<br>[0.001]***     | 0.031<br>[0.0002]*** | -0.001<br>[0.0002]***    | 0.002<br>[0.0003]***  | 0.028<br>[0.0002]*** | -0.002<br>[0.0001]***    | -0.002<br>[0.0002]***    |
| Average Altitude             |                      | 0.008<br>[0.002]***    | 0.008<br>[0.002]***    |                      | 0.0003<br>[0.002]       | -0.00003<br>[0.002]     |                      | -0.009<br>[0.001]***     | -0.010<br>[0.001]***  |                      | -0.021<br>[0.0004]***    | -0.021<br>[0.0004]***    |
| Average Rainfall             |                      | -0.0004<br>[0.004]     | 0.0002<br>[0.004]      |                      | -0.007<br>[0.003]***    | -0.009<br>[0.003]***    |                      | 0.041<br>[0.001]***      | 0.037<br>[0.002]***   |                      | 0.037<br>[0.001]***      | 0.037<br>[0.002]***      |
| Average Temperature          |                      | -0.084<br>[0.005]***   | -0.083<br>[0.006]***   |                      | -0.144<br>[0.003]***    | -0.147<br>[0.004]***    |                      | -0.115<br>[0.003]***     | -0.123<br>[0.002]***  |                      | -0.103<br>[0.003]***     | -0.103<br>[0.002]***     |
| Latitude                     |                      | 0.095<br>[0.010]***    | 0.094<br>[0.010]***    |                      | 0.156<br>[0.006]***     | 0.158<br>[0.006]***     |                      | 0.073<br>[0.003]***      | 0.079<br>[0.003]***   |                      | 0.089<br>[0.003]***      | 0.089<br>[0.003]***      |
| Land Suitability             |                      | -0.089<br>[0.003]***   | -0.089<br>[0.003]***   |                      | -0.025<br>[0.002]***    | -0.025<br>[0.003]***    |                      | 0.002<br>[0.001]**       | 0.001<br>[0.001]      |                      | 0.019<br>[0.001]***      | 0.019<br>[0.001]***      |
| Rivers and Tributaries       |                      | -0.009<br>[0.001]***   | -0.009<br>[0.002]***   |                      | -0.016<br>[0.001]***    | -0.018<br>[0.002]***    |                      | -0.019<br>[0.001]***     | -0.022<br>[0.001]***  |                      | -0.014<br>[0.0004]***    | -0.014<br>[0.0003]***    |
| Maritime Department          |                      | 0.047<br>[0.001]***    | 0.047<br>[0.002]***    |                      | 0.049<br>[0.001]***     | 0.047<br>[0.002]***     |                      | 0.023<br>[0.001]***      | 0.018<br>[0.001]***   |                      | -0.005<br>[0.001]***     | -0.005<br>[0.001]***     |
| Distance to Paris            |                      | 0.0001<br>[0.00001]*** | 0.0001<br>[0.00001]*** |                      | 0.00003<br>[0.00001]*** | 0.00005<br>[0.00001]*** |                      | -0.00003<br>[0.00004]*** | -0.00003<br>[0.00004] |                      | -0.00003<br>[0.00002]*** | -0.00003<br>[0.00002]*** |
| Paris and Suburbs            |                      | 0.011<br>[0.002]***    | 0.011<br>[0.002]***    |                      | 0.037<br>[0.001]***     | 0.038<br>[0.001]***     |                      | -0.026<br>[0.001]***     | -0.024<br>[0.001]***  |                      | -0.055<br>[0.001]***     | -0.055<br>[0.001]***     |
| Alsace-Lorraine              |                      |                        |                        |                      |                         |                         |                      |                          |                       |                      | -0.004<br>[0.001]***     | -0.005<br>[0.001]***     |
| Observations                 | 82                   | 82                     | 82                     | 82                   | 82                      | 82                      | 82                   | 82                       | 82                    | 85                   | 85                       | 85                       |

Note: The table reports spatial Conley (1999) standard errors with a radius of 100km. The post-WW1 regressions include a dummy variable for the three departments in the Alsace-Lorraine region which were under German occupation between 1871 and 1914. Robust standard errors are reported in brackets. \*\*\* indicates significance at the 1%-level, \*\* indicates significance at the 5%-level, \* indicates significance at the 10%-level.

## Appendix D. Variable definitions and sources

### Fertility

*Fertility.* Fertility in each department, computed following the methodology of the Coale fertility index. Source: Bonneuil (1997).

### Income

*GDP per capita.* Each department's GDP per capita. Source: Combes et al. (2011) and Caruana-Galizia (2013).

### Human capital

*Share of high-school graduates among conscripts .* The share of French army conscripts, i.e., 20-year-old men who reported for military service in the department where their father lived, who completed high-school. Source: *Annuaire Statistique De La France* (1878-1939).

*Share of literate conscripts.* The share of French army conscripts, i.e., 20-year-old men who reported for military service in the department where their father lived, who could read and write. Source: *Annuaire Statistique De La France* (1878-1939).

### Mortality at age 0-1

*Mortality Age 0-1.* Each department's mortality rate for children age 0-1. Source: *Annuaire Statistique De La France* (1878-1939). and Bonneuil (1997).

### Life expectancy at age 15

*Life Expectancy Age 15.* Each department's life expectancy for individuals age 15. Source: *Annuaire Statistique De La France* (1878-1939). and Bonneuil (1997).

### Wage gender gap

*Male-to-female wage ratio.* Each department's ratio of the average male wage to female wage ((in French Francs)). Source: France. Ministère du commerce, de l'industrie et des colonies (1897); France. Ministère du travail et de la prévoyance sociale (1911).

### Industrialization

*Horse power of steam engines.* This variable reports the total horse power of the steam *Engines* in the firms of each department, which is computed from the industrial survey carried out by the French government between 1860 and 1865. See Chanut et al. (2000) for details on the implementation of this survey.

## Geographic, institutional and pre-industrial characteristics of departments

*Distance to Paris.* The great circle distance as “the crow flies” from Paris, the capital of France, to the administrative center of each department. This aerial distance is computed in kilometers.

*Alsace-Lorraine.* This dummy variable takes the value one for the Bas-Rhin, Haut-Rhin and Moselle departments and zero otherwise in all the regressions on post-WWI outcomes since these three departments were under German rule between 1871 and 1918.

*Average rainfall.* The average rainfall in  $\text{cm}^3$ , reported at a half-degree resolution by Ramankutty et al. (2002), across the French departments.

*Average temperature.* The average temperature (in celsius), reported at a half-degree resolution by Ramankutty et al. (2002), across the French departments.

*Latitude.* The latitude of the centroid of each French department.

*Land suitability* The land suitability index, reported at a half-degree resolution by Ramankutty et al. (2002), across the French departments.

*Maritime department.* This dummy variable takes the value one if a French department borders the coastline and zero otherwise.

*Paris and suburbs.* This dummy variable takes the value one for the three departments, i.e., Seine, Seine-et-Marne and Seine-et-Oise, which encompass *Paris and its suburbs* and zero otherwise.

*Urban population in 1700* (thousand of inhabitants). This variable reports the total population of the major urban centers, i.e., with more than 10,000 inhabitants, in each French department in 1700 using the data in Lepetit (1994, Appendix B).

*University.* Number of universities in 1700 in each department. Source: Bosker et al. (2013).

## Instrumental variable

*Distance to Fresnes sur Escaut.* The great circle distance as “the crow flies” from Fresnes-sur-Escaut, where the first steam engine was operated in France in 1732, to the administrative center of each department. This aerial distance is computed in kilometers.

## Distance to cities

*Distance to Marseille.* The great circle distance as “the crow flies” from Marseille to the administrative center of each department. This aerial distance is computed in kilometers.

*Distance to Lyon.* The great circle distance as “the crow flies” from Lyon to the administrative center of each department. This aerial distance is computed in kilometers.

*Distance to Rouen.* The great circle distance as “the crow flies” from Rouen to the administrative center of each department. This aerial distance is computed in kilometers.

*Distance to Mulhouse.* The great circle distance as “the crow flies” from Mulhouse to the administrative center of each department. This aerial distance is computed in kilometers.

*Distance to Bordeaux.* The great circle distance as “the crow flies” from Bordeaux to the administrative center of each department. This aerial distance is computed in kilometers.

*Distance from Paris (weeks of travel).* The time needed for a surface travel from Paris to the

administrative center of each department measured in weeks of travel. Source: Özak (2010).

*Distance from Marseille (weeks of travel)*. The time needed for a surface travel from Marseille to the administrative center of each department measured in weeks of travel. Source: Özak (2010).

*Distance from Lyon (weeks of travel)*. The time needed for a surface travel from Lyon from Lyon to the administrative center of each department measured in weeks of travel. Source: Özak (2010).

*Distance from Rouen (weeks of travel)*. The time needed for a surface travel from Rouen to the administrative center of each department measured in weeks of travel. Source: Özak (2010).

*Distance from Mulhouse (weeks of travel)*. The time needed for a surface travel from Mulhouse to the administrative center of each department measured in weeks of travel. Source: Özak (2010).

*Distance from Bordeaux (weeks of travel)*. The time needed for a surface travel from Bordeaux to the administrative center of each department measured in weeks of travel. Source: Özak (2010).

### **Access to waterways**

*Rivers and Tributaries*. This dummy variable takes the value 1 if at least one of the main French rivers or tributaries (whose total length is above 300 km) crosses a given department. These are the Rhin, Loire, Meuse, Rhône, Seine, Garonne, Dordogne, Charente and Escaut.

### **Past levels of education**

*Share of Grooms who Signed their Wedding Licenses, 1686-1690, 1786-1790 and 1816-1820*. The share of grooms who signed their wedding licenses with their names over the 1686-1690, 1786-1790 and 1816-1820 periods (as opposed to those who marked it with a cross). Source: Béaur, Gérard, and Béatrice Marin. 2011. La Statistique Générale de la France Présentation. L'Atelier du Centre de recherches historiques. <http://acrh.revues.org/index2891.html>.

### **Share of Catholics in the population**

*Share of Catholics, 1861*. Share of Catholics in the population in each department. Source: Béaur, Gérard, and Béatrice Marin. 2011. La Statistique Générale de la France Présentation. L'Atelier du Centre de recherches historiques. <http://acrh.revues.org/index2891.html>.

### **Economic integration**

*Market integration during the French Revolution*. The number of external suppliers for each department in the 1790s for the following categories of products: cotton, hosiery, hardware, misc. production goods, misc. consumption goods, linen and hemp, wool and wool cloth, leather products hides and hats, iron, Food items, drinks, paper, wood for industry, fuel (wood and coal). Source: Daudin (2010).

*Railroad connection to Paris in 1860*. This dummy variable takes the value 1 if the administrative center of the department was connected to the railroad network in 1860. Source: Caron (1997).



## The presence of raw materials

*Area covered by mines in department.* The area covered by coal mines in 1837 in each department. Source: France - Ministère des Travaux Publics (1838). Statistique de l'industrie minérale et des appareils à vapeur en France et en Algérie, Paris.

*Iron forges, 1789 and 1811.* The number of iron forges in each department in 1789 and 1811. Source: Woronoff (1997).

## Industrial concentration, 1861

*Concentration index.* This variable computes the Herfindahl index of industry concentration for each department using the 16 different industries listed in the 1860-1865 industrial survey (textile, mines, metallurgy, metal objects, leather, wood, ceramics, chemistry, construction, lighting, furnitures, clothing, food, transportation, sciences & arts, and luxury goods). The Herfindahl index of industry concentration is defined as,  $H_d = \sum_{i=1}^{16} (E_{i,d}/E_d)^2$ , where  $H_d$  is the Herfindahl concentration index for department  $d$ ,  $E_{i,d}$  is the horse power of the steam engines in the firms in sector  $i$  of department  $d$  and  $E_d$  is the horse power of the steam engines in the firms of department  $d$ . Source: Chanut et al. (2000)

## 19th century population

*Population density, 1801, 1831 and 1861.* Source for the data on population: Béaur, Gérard, and Béatrice Marin. 2011. La Statistique Générale de la France Présentation. L'Atelier du Centre de recherches historiques. <http://acrh.revues.org/index2891.html>. The area covered by each department is computed via GIS.

## Building destruction and military casualties in World War I

*World War I Building Destruction.* Number of buildings destroyed in World War I. Source: Michel (1926, 1932)

*Soldier deaths, World War I and World War II.* Number of soldiers born in each department who died in World War I and in World War II. Source: French Ministry of Defense's website [www.memoiredeshommes.sga.defense.gouv.fr](http://www.memoiredeshommes.sga.defense.gouv.fr).