Technology-Skill Complementarity in Early Phases of Industrialization

Technology-Skill Complementarity

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Abstract: The research explores the effect of early industrialization on human capital formation. Exploiting exogenous regional variations in the adoption of steam engines across France, the study suggests that, in contrast to conventional wisdom that views early industrialization as a predominantly deskilling process, the industrial revolution was conducive for human capital formation, generating wide-ranging gains in literacy rates and educational attainment. However this increase in human capital formation was limited to basic literacy and numeracy and did not entail an increase in the share of pupils in middle and high-school in the population.

Keywords: Economic Growth, Industrialization, Human Capital, Steam Engine, Technology-Skill Complementarity

Classification: N33, O14, O33

1   Introduction

While it has been widely recognized that technology-skill complementarity has characterized the nature of technological progress in advanced stages of development (Goldin and Katz, 1998), stimulating human capital formation and fostering inequality, earlier stages of industrialization have been predominantly viewed as a deskilling process, depressing skill formation and diminishing inequality (Acemoglu, 2002). This deeply entrenched view of the nature of the industrial revolution has been primarily based on anecdotal evidence that has highlighted the adverse effect of the emergence of factories and assembly lines on the demand for artisans and literate workers.[1] Yet, as has been the case in other technological revolutions in the course of human history, the process of creative destruction that was associated with the emergence of new industrial technology could have plausibly fostered the demand for new skills while rendering existing ones obsolete.[2]

This research explores the effect of industrialization on human capital formation. In contrast to conventional wisdom that views early industrialization as a predominantly deskilling process, the study establishes that the industrial revolution was conducive to human capital formation, generating broad-based gains in literacy rates and educational attainment. The research therefore lends further credence to the emerging view that human capital was instrumental in the transition from stagnation to growth and the associated divergence in the wealth of nations in the past two centuries (Galor, 2011; Galor and Weil, 2000; Galor and Moav, 2002; Galor and Mountford, 2008).[3]

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[1]This view has been formed based on evidence from the US (e.g., Brown and Phillips, 1986; Atack *et al.*, 2004) and England (e.g., Mitch, 1992). It regards literacy as largely a cultural skill or a hierarchical symbol with a limited role in the production process in the first stage of industrialization.

[2]For instance, Katz and Margo (2013) find that while industrialization in the US was associated with the replacement of artisans by low skill labor, the process was accompanied by an increased demand for high-skilled workers. See also Atack *et al.* (2019) as well as the survey by Becker and Woessmann (2019).

[3]Doepke (2004), Cervellati and Sunde (2005) and Lagerlöf (2006) further underline the human capital channel.

The exploration of the impact of industrialization on skill formation is associated with significant empirical hurdles. First, the observed relationship between industrialization and human capital formation may reflect the effect of human capital on the advancement and the adoption of industrial technology rather than the impact of the process of industrialization on human capital formation.[4] Second, the effect of institutional, cultural, geographical and human characteristics on the joint evolution of industrialization and human capital formation may have governed the observed relationship between these two forces. In light of these empirical hurdles, a desirable empirical setting will be an economy where: (i) the territory consists of distinct administrative units in which institutional, cultural, human and geographical characteristics are unlikely to differ significantly, (ii) the creation of these administrative units was independent of the process of industrialization and is orthogonal to the subsequent process of human capital formation, (iii) exogenous source of variation in the intensity of industrialization across these administrative units could be identified, and (iv) extensive data on the process of development and human capital formation in each of these units is available for these early stages of industrialization.

In particular, the evolution of the French economy during its early phases of industrialization appears ideally suited for this empirical exploration for several reasons. First, as early as 1790, the French territory was divided into administrative units of nearly equal size called departments. They were designed to ensure that travel distance by horse from any location within the department to the main administrative center would not exceed one day. Furthermore, each department was subdivided into lower levels of administrative units of approximately similar size called arrondissements. Hence, one can plausibly argue that the borders of these administrative units were orthogonal to the

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[4]Human capital indeed appears to have had an effect on development in the pre-industrial era. Boucekkine *et al.* (2007) demonstrate the importance of literacy in urbanization and the transition from stagnation to growth. Becker *et al.* (2011) show the impact of education on industrialization in Prussia. Squicciarini and Voigtländer (2015) suggest that the upper tail of the human capital distribution in the second half of the 18th century had a positive effect on urbanization and wages in some industrial sectors in the subsequent decades. Furthermore, de la Croix *et al.* (2018) establish the importance of apprenticeship in the emergence of industrialization in England.

process of industrialization. Second, French administrative units have been subjected to an intensive institutional and cultural unification that mitigated initial cultural differences across regions. Third, exogenous sources of variation in the intensity of industrialization across these administrative units could be plausibly detected. Finally, the availability of extensive data on the time paths of the intensity of industrialization, human capital formation, income per capita, fertility rates, wages, economic integration and the presence of natural resources across these administrative units of the French territory permits a careful examination of the proposed hypothesis.

The study utilizes French regional and individual data from the first half of the 19th century to explore the impact of the adoption of industrial technology on human capital formation. It establishes that areas which were characterized by more intensive industrialization achieved higher levels of human capital formation. Given the potential endogeneity of industrialization and human capital formation, the study exploits regional variations in the adoption steam engine across France to establish the causal effect of industrialization on human capital. The identification strategy is based on plausibly exogenous variations in the adoption of steam engines across regions that emerges from two distinct components: (i) an exogenous source of variation in the regional diffusion, and thus in the supply of the steam engine, and (ii) an exogenous source of variation in the differential decline in the profitability of agriculture across regions, and thus in the demand for the steam engine.

In light of the use of the steam engine in the early phase of industrialization (Mokyr, 1990; Bresnahan and Trajtenberg, 1995; Aghion *et al.*, 2002; Rosenberg and Trajtenberg, 2004), the study takes advantage of historical evidence regarding the regional diffusion of the steam engine (Ballot, 1923; Sée, 1927; Léon, 1976) to identify the effect of regional variations in the intensity of steam engine adoption in 1839-1847 on human capital formation. In particular, it exploits the

distance of each administrative unit from Fresnes-sur-Escaut (in the Nord department), where a steam engine was first successfully operated for commercial use from 1732 onwards, as an exogenous source of variation in industrialization across France.[5]

Indeed, in line with the historical account, the distribution of steam engines across France is indicative of a local diffusion process from Fresnes-sur-Escaut. Accounting for confounding geographical and institutional characteristics, pre-industrial development as well as distances from major economic centers, if the distance of a department away from Fresnes-sur-Escaut was to increase from the 25th (327 km) to the 75th percentile (659 km) of the distance distribution, this department would experience an aggregate drop of 10.77 in the number of steam engines (relative to a sample mean of 29.2 and a standard deviation of 66.1).

The validity of the distance from Fresnes-sur-Escaut as one of the two instrumental variables for the intensity of steam engine adoption across France is enhanced by three additional factors. First, conditional on the distance from Fresnes-sur-Escaut, distances between each department and major centers of economic power in 1839-1847 (e.g., Paris, Marseille, Lyon, Rouen and Mulhouse) are not significantly correlated with the intensive use of the steam engine over this period. Second, the distance from Fresnes-sur-Escaut is not significantly correlated with economic development across France in the pre-industrial period. Finally, the distance between Nord and other departments appears to be orthogonal to the level and the growth rate of human capital formation across departments in the pre-industrial period.

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[5]In 1726, an Englishman named John May obtained a privilege to operate steam engines to pump water throughout the French kingdom. With another Englishman named John Meeres, he installed the first steam engine in Passy (which was then outside but is now within the administrative boundaries of Paris) to raise water from the Seine river to supply the French capital with water. However it seems that their commercial and industrial operation stopped quickly or even never took off. Indeed, when Forest de Bélidor (1737) published his treatise on engineering in 1737-1739, he mentioned that the steam engine in Fresnes-sur-Escaut was the only one operated in France (see, e.g., Lord, 1923; Dickinson, 1939).

Moreover, in view of the hypothesis that industrialization was more pronounced in areas that experienced a decline in the profitability of agricultural production, variations in the standardized net increase in wheat prices from their previous trends are exploited to identify market conditions which would be conducive for the adoption of steam engines in each department, conditional on the distance from the local geographical origin of the steam engine, (i.e., Fresnes-sur-Escaut). In particular, conditional on the distance from Fresnes-sur-Escaut, in comparison to a department at the 25th percentile of the net increase in wheat prices (-0.72), a department at the 75th percentile (-0.14), will have 0.47 fewer steam engines (relative to a sample mean of 29.2 and a standard deviation of 66.1). These estimates suggest that, while the diffusion of the steam engine as well the transition from agriculture to industry contributed to the pace of the adoption of steam engines across departments, the contribution of the gradual diffusion of steam engines from the North of France to the rest of the country was larger (in absolute value) than the effect of the net increase in wheat prices on the slower transition from agriculture to industry in the 19th century.

The analysis is conducted at the regional as well as the individual level, using three distinct samples: 85 departments, 355 arrondissements, and 7,158 individuals. It establishes that the intensity in the use of steam engines in industrial production in the 1839-1847 period had a positive and significant impact on the formation of human capital in the early stages of the industrial revolution in France.[6] In particular, the analysis suggests that a greater number of steam engines in a given administrative area in 1839-1847 had a positive and significant effect on (i) the share of children in primary schools in 1840, (ii) the share of literate individuals among French army conscripts born between 1839 and 1848, (iii) the ability of men and women born in each department

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[6]The available data do not enable us to distinguish whether the results are mainly driven by industrial or parental demand for education. These two processes are intimately linked: actual (or predicted) industrial demand for human capital is a necessary condition for the increase in the parental demand for education. It is unlikely that the information possessed by parents regarding the emergence of skill-intensive jobs outside the textile sector was superior to that possessed by industrialists.

in the 1839-1848 period to sign their wedding license, (iv) the number of primary school teachers in 1840, and (v) public spending on primary schooling by local governments over the 1855-1863 period. However, the analysis indicates that the use of steam engines in industrial production did not have a robust positive significant effect on the share of pupils in middle and high-schools in 1842. This result suggests that industrialization in the early phases of the industrial revolution did not provide incentives to invest in human capital formation beyond basic literacy skills for most of the population.[7]

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 human capital formation. First, it accounts for the potentially confounding impact of exogenous geographical characteristics (i.e, latitude, land suitability, average temperature, average rainfall and share of carboniferous area) of each French region (i.e., departments or arrondissements) on the relationship between industrialization and human capital formation. In particular, 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. Second, it captures the potentially confounding effects of the location of each region (i.e., border regions, maritime regions and regions at a greater distance from the concentration of political and economic power in Paris) on the diffusion of the steam engine and the diffusion of development. Third, the analysis accounts for the differential level of development across France in the pre-industrial era that may have affected jointly skill formation and the process of industrialization. In particular, it takes into account the potentially confounding effect of the persistence of pre-industrial development and

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[7]de Pleijt *et al.* (2020) follow our methodology and use exogenous variations in steam engines in 19th century England to explore the impact of the industrial revolution on low- and high-skilled occupations rather than formal education. They find that industrialization increased in the share of 'high-quality workmen' as well as the share of share of unskilled workers

the persistence of pre-industrial literacy rates. Finally, the analysis suggests that the findings are robust to the inclusion of additional potentially confounding factors, such as the presence of raw material, measures of early economic integration, past population density and past fertility rates.

The remainder of this article is as follows. Section 2 presents our data. Section 3 discusses our empirical strategy. Section 4 presents our main results. Section 5 provides concluding remarks.

2   Data

This section presents the regional and individual data on industrialization and human capital formation across the 85 mainland French departments, as well as across the 355 arrondissements when the data are available, based on the administrative division of France in the 1839-1847 period. It also presents the geographical and the institutional characteristics of these administrative units. 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/arrondissement was therefore orthogonal to the pre-industrial wealth levels and literacy rates while the subsequent minor changes in the borders of some of these administrative units reflected political forces rather than the effects of industrialization, the adoption of the steam engine and human capital formation.

Appendix A provides the descriptive statistics the variables used in the analysis while Appendix I gives the definitions and sources of these variables. In particular, Table A.1 reports the descriptive statistics all dependent and independent variables at the department level, Table A.2 provides them at the arrondissement level, Table A.3 provides descriptive statistics for the individual level data on the ability of brides and grooms to sign their wedding license, while Table A.4 provides additional descriptive statistics regarding the composition of steam engines across various industrial sectors.

2.1   Measures of Human Capital

2.1.1   Schooling

To assess the impact of early industrialization on schooling across France, we use data on the share of primary school pupils in each department as well as on the share of middle- and high-school pupils in each arrondissement.

A. Share of Primary School Pupils in   B. Share of Middle & High-School Pupils in   C. Share of Literate Individuals among

Population 5-15, 1840.   Total Population, 1842.   Conscripts born 1839-1848.
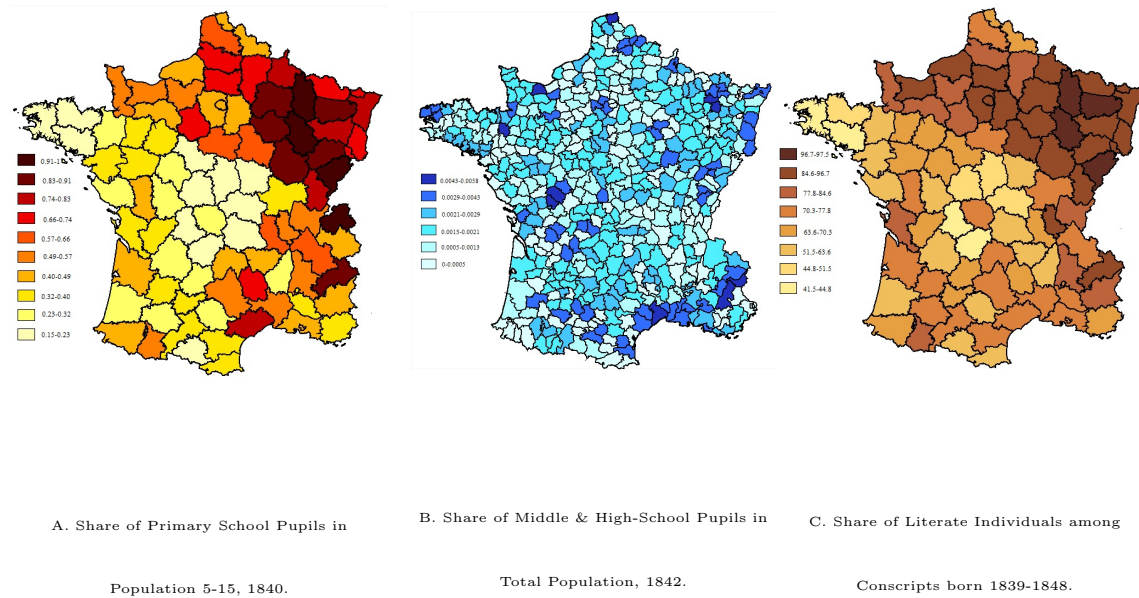
Figure 1. *Shares of pupils in 1840, middle- and high-school pupils in 1842 and literate conscripts born between 1839 and 1848.*

First, the study explores the impact of industrialization on the share of pupils enrolled in the primary schools of each department out of the population age 5-15 in 1840, as depicted in Panel A of Figure 1. There were on average 33,962 pupils in each department in 1840, i.e., 49.1% of the population age 5-15.[8]

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[8]It should be noted that Article 9 of the 28 June 1833 Loi sur l'instruction primaire (i.e., often referred to as "Loi Guizot"after the name of the then Education minister François Guizot) stated that each commune must fund, on

Second, the study explores the impact of industrialization on the share of middle-and high-school pupils in 1842 across the 355 French arrondissements, as depicted in Panel B of Figure 1. The average share (respectively, number) of middle- and high-school pupils in the population of each arrondissement was 0.15% (147.5). This low level may have reflected two aspects of secondary education in 19th c. France which are not mutually exclusive. On the one hand, most parents were unable to afford education beyond primary school during the 19th century such that high-schools, which almost functioned independently of primary schools, were only reserved for an elite. On the other hand, there were only limited incentives to invest beyond basic literacy skills for the overwhelming majority of the population (Mayeur, 2003).

It is worth noting that the level of analysis may play an important role: while Panel A of Figure 1 suggests that there were limited variations in primary school enrollment across the North-east of France at the department level, Panel B of Figure 1 shows that there were substantial variations in secondary school enrollment across the arrondissements of this region.

2.1.2 Literacy

The impact of early industrialization on literacy during the first phase of the industrial revolution is captured by two measures at different levels of aggregation. First, at the department level, the analysis relies 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 could read and write. Specifically, the analysis focuses on the share of literate conscripts over the 1859-1868 decade, i.e., men who were born between 1839 (when the industrial survey began) and 1848 (a year after the survey was officially completed). The data, which are mapped in Panel C of Figure 1 and reported in Table

its own or jointly with other communes, an "elementary" primary school (Ecole Primaire Elémentaire), regardless of population size. The law also compelled communes with more than 500 inhabitants to have a school building in their jurisdiction (Montalbo, 2021). We discuss this issue in Appendix C.7 and specifically in Appendix Table C.18.

A.1, show that 74.0% of the French conscripts born between 1839 and 1848 were literate. It is worth noting that every Frenchman had to report for military service during the 19th century, and it was at this moment that each one was given a literacy test as part of a general assessment of his physical and intellectual abilities: the data on the conscripts' literacy are therefore not subject to selection bias because every man had to report for military service (modifications in conscription rules during the 19th century were such that not every man eventually served in the army (Crépin, 2009)).

Second, at the individual level, the study relies on the *Enquête des 3000 familles* (Survey of the 3000 Families). It provides information as to whether men and women whose last name starts by the three letters TRA, as well as their spouses, signed their wedding licenses or just marked it with a cross.[9] Since this dataset provides the year of birth and the birth department of these brides and grooms, it enables us to assess the impact of industrialization on the literacy of spouses born between 1839 and 1848. Naturally, there might be concerns regarding the representativeness of this dataset: Abramitzky *et al.* (2011) nevertheless found it to be representative of nuptiality patterns while Daudin *et al.* (2019) showed its representativeness for the internal migration patterns of the whole French population.

2.1.3 Alternative Measures of Human Capital Formation: Teachers and Public Spending on Education

The study assesses the impact of industrialization on additional variables which are related to schooling and literacy but are slightly imprecise measures of human capital formation: primary school teachers in 1840, and public expenditures on primary schooling over the 1855-1863 period.

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[9]The ability to sign a wedding license can be viewed as a lower bound on literacy, but obviously does not fully assess the ability to read and write.

Indeed, local variations in these variables may not only reflect the demand for education from parents or employers, but also the efforts of local interest groups as well as the local decision-makers' view about the trade-off between the quality and the quantity of education in the presence of resource constraints.

A survey undertaken in 1840 by the French bureau of statistics (*Statistique Générale de la France*) indicates that there were on average 742 primary school teachers per department in 1840. This survey also shows that there was considerable variation in the number of teachers across departments as be seen in Appendix Figure A.1 which maps the distribution of primary school teachers within France in 1840.

Moreover, the French bureau of statistics (*Statistique Générale de la France*) provides data on public spending on primary schooling per inhabitant at the department level during the 1855-1863 period. The data distinguish between the expenditures of the three tiers of the French government which funded primary schooling, i.e., the communes, the departments and the central state. As can be seen in the descriptive statistics reported in Table A.1, and in line with the historical evidence which we discuss in the Appendix, most of the public spending on primary schooling was undertaken by the communes in mid-19th century France. It was only after the passing of the laws on mandatory and free schooling in 1881-1882 that the central state begun to finance primary schooling (see, e.g., Mayeur, 2003; Franck and Johnson, 2016; Squicciarini, 2020).

2.2   Steam Engines

The research explores the effect of the introduction of industrial technology on human capital formation. In light of the pivotal role played by the steam engine during the early stage of the industrial revolution, it exploits variations in the industrial use of the steam engine across France.

Specifically, the analysis focuses on the number of steam engines used in each French depart-ment/arrondissement as reported in the industrial survey carried out by the French bureau of statistics (*Statistique Générale de la France*) between 1839 and 1847 (Chanut *et al.*, 2000).[10] In Figure 2, Panel A shows the distribution of steam engines at the department level while Panel B shows it at the arrondissement level.

A. Departments.

B. Arrondissements.
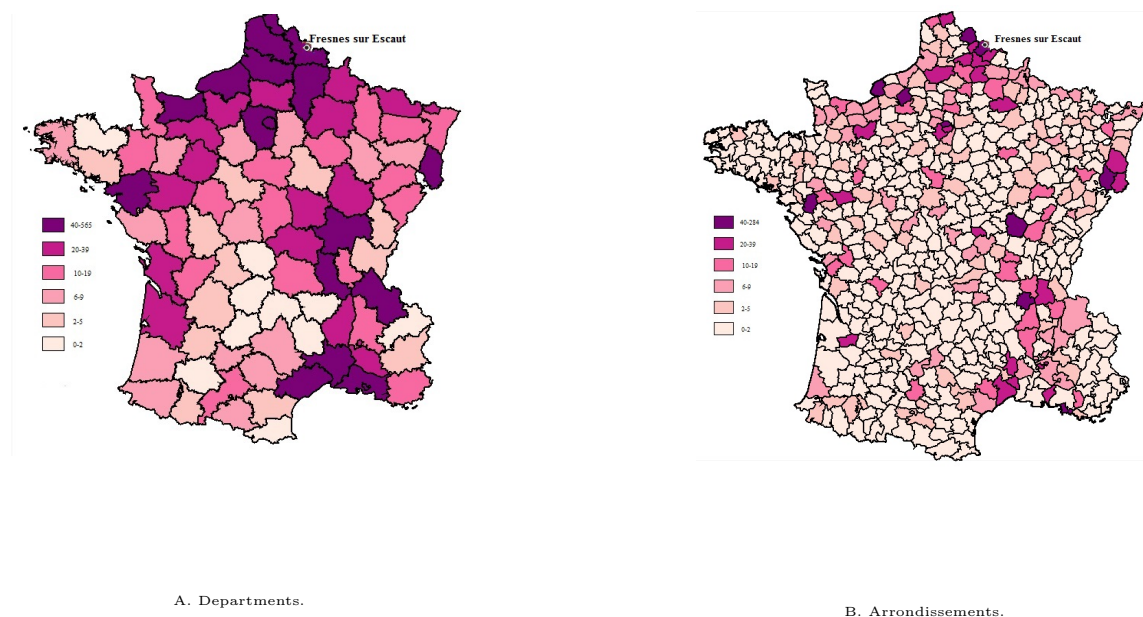
Figure 2. *The distribution of the number of steam engines across mainland France, 1839-1847*

As shown in Figure 2, and analyzed further in the discussion of the identification strategy in Section 3, the distribution of the steam engines across French administrative units in 1839-1847 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 successfully used

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[10]As discussed by Chanut *et al.* (2000), the survey started in 1839 and was nearly completed in 1841 when it was halted under popular pressure, amid growing fears that the survey data would be used to support governmental fiscal reforms. It was only in 1844 that the central government restarted the survey which was eventually completed in 1847. However, it appears that, to a large extent, local civil servants did not collect new information but simply resent the results of the 1839-1841 survey to the central government.

for industrial purposes in 1732. The largest number of steam engines was indeed in the northern part of France. There were fewer in the East and in the South-East, and even less so in the South-West. Seven departments had no steam engine in 1839-1847 (i.e., Cantal, Côtes-du-Nord, Creuse, Hautes-Alpes, Haute-Loire, Lot and Pyrénées-Orientales).[11]

Furthermore, Table A.4 reports descriptive statistics for the number of steam engines in each of the 16 sectors listed in the 1839-1847 survey: ceramics, chemistry, clothing, construction, food, furniture, leather, lighting, luxury goods, metal objects, metallurgy, mines, sciences & arts, textile, transportation and wood. The data show that the five sectors with the largest average horse power from steam engines per department are textile, food, mines, metallurgy and metal objects. In this respect, we note that the textile sector had the largest number of steam engines of all the sectors: there were twice as many steam engines in textile than in the food industry and three times more than in the mining sector. Moreover the descriptive statistics on the number of workers in each of the 16 sectors reported in Table A.4 indicate that the chemistry and wood sectors had a larger ratio of steam engine per worker, most likely because the textile sector employed many individuals whose work did not require steam engines.

2.3   Confounding Characteristics

The empirical analysis accounts for observable exogenous confounding geographical and institutional characteristics of each department/arrondissement which may have contributed to the relationship between industrialization and human capital formation. Geography may have impacted agricultural productivity as well as the pace of industrialization, and thus income per capita and investments in education. Institutions may have affected jointly the process of industrialization and the increase

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[11]Côtes-du-Nord, Creuse and Lot were rural areas out of the main internal trade axes while Cantal, Hautes- Alpes, Haute-Loire and Pyrénées-Orientales were located in mountainous zones. It is therefore not surprising that these departments had not yet adopted steam-powered technology by the 1840s.

in literacy. Besides, geographical and institutional factors may have jointly affected human capital indirectly by governing the speed of the diffusion of steam engines across France.

2.3.1 Geographic characteristics

The empirical analysis takes into account the potentially confounding impact of the exogenous geographic characteristics of each French department/arrondissement on the relationship between industrialization and human capital. Specifically, it captures the potential effect of these geographical factors on the profitability of the adoption of the steam engine, on the pace of its regional diffusion and thus, on human capital formation during the first stages of the industrial revolution.

First, the study accounts for climatic and soil characteristics of each department/arrondissement, i.e., land suitability, average temperature and average rainfall (Ramankutty *et al.*, 2002). These characteristics, which are mapped in Appendix Figure A.2, could have affected natural land productivity and therefore, the feasibility and profitability of human capital investments and of the transition to the industrial stage of development. Besides, the diffusion of the steam engine across France could have been affected by the presence of raw material required for industrialization. The regressions thus account for the share of carboniferous area in each department/arrondissement.

2.3.2 Institutional Characteristics

By focusing on the impact of variations in the adoption of the steam engine on human capital formation across France, the empirical analysis ensures that institutional factors which were unique to France as a whole are not the source of the differential pattern of human capital across these regions. Nevertheless, one region of France had a unique exposure to institutional characteristics that may have contributed to the observed relationship between industrialization and literacy. The emergence of state centralization in France and the concentration of political power in Paris before

the industrial revolution may have had a differential impact on the political culture and economic prosperity in Paris and its suburbs, i.e., Seine, Seine-et-Marne and Seine-et-Oise. Hence, the analysis includes a dummy variable for these three departments, which encompass 14 arrondissements, to control for their potential confounding effects on the observed relationship between industrialization and human capital. Moreover, the analysis accounts for the effect of the aerial distance between the administrative center of each department/arrondissement and Paris, thus capturing the potential decline in the reach of the central government in areas at a greater distance from Paris as well as the diminished potential diffusion of development into these regions.

3   Empirical Methodology

3.1   Empirical strategy

The relationship between industrialization and human capital formation may reflect the impact of the process of industrialization on human capital formation as well as the effect of human capital on the advancement and the adoption of industrial technology. Furthermore, the potential impact of institutional, geographical, and cultural characteristics on the joint evolution of industrialization and human capital accumulation may govern the association between these two forces. Hence, in light of the potential endogeneity of industrialization and human capital formation, this research exploits exogenous regional variations in the adoption of the steam engine across France to establish the causal effect of industrialization on human capital. In what follows, we present the two components of the identification strategy.

3.1.1   The regional diffusion of the steam engines in 19th c. France

The first component is motivated by the historical account of the gradual regional diffusion of the steam engine in France during the 18th and 19th centuries (Ballot, 1923; Sée, 1927; Léon, 1976). Considering the positive association between industrialization and the use of the steam engine (Mokyr, 1990; Bresnahan and Trajtenberg, 1995; Aghion *et al.*, 2002; Rosenberg and Trajtenberg, 2004), the study takes advantage of the regional diffusion of the steam engine to identify the effect of local variations in the intensity of the use of the steam engine during the 1839-1847 period on the process of development. In particular, it exploits the distances between each French administrative unit and Fresnes-sur-Escaut (in the arrondissement of Valenciennes in the Nord department), where the first successful commercial application of the steam engine in France was made in 1732, as an instrument for the use of the steam engines in 1839-1847.[12]

Consistent with the diffusion hypothesis, the second steam engine in France that was successfully utilized for commercial purposes was operated in 1737 in the mines of Anzin, also in the Nord department, less than 10 km away from Fresnes-sur-Escaut. The third steam engine in France was installed in 1749 in the coal mine of Littry (about 50km from Caen) in Normandy. There were three steam engines in the mines of Saint-Georges-Chatelaison in the Anjou province in the West of France in 1749. Additional machines were installed in the mines of Anzin and Fresnes-sur-Escaut: there were four steam engines in Anzin in 1756 and six in Fresnes sur Escaut in 1791 (Ballot, 1923; Léon, 1976).

Steam engines also began to be built in France, when the first workshop was established in 1750 in Maubeuge, about 50km from Fresnes. Still the main impulse for construction of steam engines in France began in 1778 when two entrepreneurs, the Périer brothers, started building the Watt

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[12]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).

steam engine in Paris. Between 1778 and 1791, they built about 40 steam engines, some of which they were also able to export. Other workshops were opened in the 1780s, in Beauchamp (Haute Saône) and in Choisy-sur-Seine, near Paris. This increase in competition triggered a decline in the price of steam engines. The steam engine in Fresnes in 1732 was said to have cost 75,000 livres but a similar machine only cost half in the 1770s.

The local production of steam engines progressively enabled the use of steam engines in sectors other than mining. They were used in paper mills as well as to irrigate gardens with fountains. Still all historical accounts suggest that the use of steam engines in France in 1789 was more limited than in England. Attempts at building steam powered boats and ships had failed. What is more, the turmoil of the Revolution and the wars of the Empire slowed down the spread of the steam engine in 1815. There is nonetheless anecdotal evidence that new machines were installed, mainly in the North and East of France. For instance, engines were first installed in Saint-Quentin in 1803 as well as in Mulhouse and Strasbourg in 1812.

After 1815, the diffusion of the steam engine was not impeded by wars anymore. However historical evidence suggests that places which were geographically closer to Fresnes-sur-Escaut kept their "first-mover" advantage. In particular, new steam engine workshops were opened in Lille in the North of France, as well as in the East in Strasbourg and Mulhouse. Part of these steam engines were used in the growing metallurgy and mining industries in the nearby regions. Conversely, in the South of France, the adoption of steam-powered technology progressed at a slower place before 1850. For instance, in Marseille, there were only two steam-powered gristmills in 1830 (Sée, 1927).

Indeed, in line with the historical account, the distribution of steam engines across French departments, as reported in the 1839-1847 industrial survey, is indicative of a local diffusion process from Fresnes-sur-Escaut, both at the department level as shown in Panel A of Table 1 and at the

Table 1. *The geographical diffusion of the steam engine from Fresnes-sur-Escaut*

Panel A. Department-Level Regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.273***	-0.472**	-0.681***	-0.681***		-1.074***
	[0.0597]	[0.218]	[0.230]	[0.230]		[0.279]
Distance to Paris					-0.0268	0.628**
					[0.254]	[0.262]
Geographic Characteristics	No	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	29.2	29.2	29.2	29.2	29.2	29.2
Adjusted R2	0.188	0.271	0.290	0.290	0.209	0.325
Observations	85	85	85	85	85	85

Panel B. Arrondissement-Level Regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.163***	-0.0717***	-0.0708***	-0.0708***		-0.230**
	[0.0292]	[0.0272]	[0.0271]	[0.0271]		[0.0922]
Distance to Paris					-0.0500*	0.219**
					[0.0302]	[0.110]
Geographic Characteristics	No	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	6.97	6.97	6.97	6.97	6.97	6.97
Adjusted R2	0.090	0.591	0.607	0.607	0.601	0.613
Observations	355	355	355	355	355	355

Note: This table presents the results of OLS regression analysis of the geographical diffusion of the steam engine across departments in France, as captured by the negative association between the number of horse power of steam engines used in department/arrondissement in 1839-1847 and the distance (in kilometers) of the department/arrondissement from the location of the first commercial use of the steam engine in France (Fresnes-sur-Escaut). The regressions accounts for a range of geographical and institutional characteristics. Geographic characteristics include the department/arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

arrondissement level as shown in Panel B of Table 1 (Appendix Tables B.1 and B.2 show the regression results with the full controls). As reported in Column (1) of both panels of Table 1, there is a highly significant negative unconditional association between the number of steam engines in each department and the distance of the administrative center of each department from Fresnes-sur-Escaut. Nevertheless, this association may be partly governed by the confounding effects of geographic and institutional characteristics on the pace of technological diffusion, as well as on the process of development. Thus, in order to mitigate these potential effects of unobserved heterogeneity, the analysis accounts for a wide range of these characteristics (latitude, rainfall, land suitability, maritime and border departments, Paris and its suburbs, the distance to Paris). Reassuringly, the unconditional negative relationship between the number of steam engines and the distance to Fresnes-sur-Escaut remains highly significant and is larger in absolute value when the analysis accounts for exogenous confounding geographical controls such as land suitability, latitude, rainfall and temperature (Column (2)), as well as institutional factors (Column (3)).

Importantly, the diffusion pattern of steam engines to each department is not significantly correlated with the distance between Paris in Column (4) of Panel A of Table 1. Moreover, as reported in Column (5) of Table 1 and Panel A of Appendix Figure A.4, the highly significant negative association between the intensity in the use of steam engines in each department and its distance from Fresnes-sur-Escaut is unaffected when the distance to Paris is accounted for. Similar results can be seen in Panel B of Table 1 and in Panel B of Appendix Figure A.4 where the regressions are at the arrondissement level.

The plausibility of the use of aerial distance from a department to Fresnes-sur-Escaut as an instrumental variable for its number of steam engines is further enhanced by a few additional empirical findings. As established in Table 2, the number of steam engines in the 1839-1847 period in each

Table 2. *The geographical diffusion of the steam engine: Insignificance of distances from other major cities*

Panel A. Department-Level Regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.27***	-0.33***	-0.27***	-0.37***	-0.27***	-0.324***
	[0.060]	[0.074]	[0.058]	[0.12]	[0.081]	[0.101]
Distance to Marseille		-0.077				
		[0.096]				
Distance to Lyon			0.016			
			[0.099]			
Distance to Rouen				0.115		
				[0.142]		
Distance to Mulhouse					-0.012	
					[0.084]	
Distance to London						0.0587
						[0.112]
Mean Value of the Dependent Variable	29.2	29.2	29.2	29.2	29.2	29.2
Adjusted R^2	0.19	0.19	0.18	0.18	0.18	0.18
Observations	85	85	85	85	85	85

Panel B. Arrondissement-Level Regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.163***	-0.220***	-0.163***	-0.265***	-0.153**	-0.226***
	[0.045]	[0.049]	[0.042]	[0.098]	[0.060]	[0.0456]
Distance to Marseille		-0.081				
		[0.052]				
Distance to Lyon			-0.002			
			[0.059]			
Distance to Rouen				0.128		
				[0.104]		
Distance to Mulhouse					-0.022	
					[0.058]	
Distance to London						0.0739
						[0.0460]
Mean Value of the Dependent Variable	6.97	6.97	6.97	6.97	6.97	6.97
Adjusted R2	0.090	0.098	0.087	0.098	0.088	0.093
Observations	355	355	355	355	355	355

Note: This table establishes that the negative association between the number of horse power of steam engines used in the department/arrondissement in 1839-1847 and the distance of the department/arrondissement (in kilometers) from the location of the first commercial use of the steam engine in France – Fresnes-sur-Escaut – is unaffected by distances from other major cities in France and from London. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

department/arrondissement is not significantly correlated with the aerial distances between each department/arrondissement and London, the capital of the United Kingdom that was the birthplace of the industrial revolution, as well as with the major French economic centers. Specifically, conditional on the distance from Fresnes-sur-Escaut, distances between each department/arrondissement and Marseille and Lyon (the second and third largest cities in France), Rouen (a major harbor in the north-west where the steam engine was introduced in 1796) and Mulhouse (a major city in the east where the steam engine was introduced in 1812) are not significantly correlated with steam engines in 1839-1847, lending credence to the unique role of the introduction of the first steam engine in Fresnes-sur-Escaut in the diffusion of the steam engine across France. Besides, as reported in Appendix Table B.3, the qualitative results are unaffected by the use of surface distances, as captured by the time needed for a surface travel between any pair of locations (Özak, 2018).[13]

Moreover, in contrast to its pivotal role in the industrial era, the distance to Fresnes-sur-Escaut is not significantly correlated with economic development and human capital formation in the pre-industrial period. As established in Appendix Table B.4, the distance to Fresnes is not significantly correlated with the presence of a university in 1700 (Frijhoff, 1996) at the department- and arrondissement-level. Moreover, the distance to Fresnes is not significantly correlated with the distance between the main town (chef-lieu) of the department/arrondissement and the closest university in 1700. In addition, the distance to Fresnes is not significantly correlated with the literacy rate of each department in 1686-1690 (Furet and Ozouf, 1977) or with the rank of each department in the distribution of literacy rates 1686-1690.[14] Finally, Appendix Table B.4 also shows that the

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[13]Additional regressions in Appendix Tables C.5-C.8 show that the main results are robust to using various measures of market integration, notably the development of the railroad in the 19th century.

[14]See Appendix Figures A.3 and A.6 for the geographical distribution of universities in 1700 and literacy data in 1686-1690. It is worth pointing out that the literacy data from 1686-1690, 1786-1790 and 1816-1820 data show that the North of France was more literate than the South, but that the Nord department was never the most literate department. In fact, the share of literate individuals in the Nord department was equal to 10.5% in 1686-1690 (mean 25.9%; std. dev. 14.9%), 51.4% in 1786-1790 (mean 42.4%; std. dev. 23.9%) and 48.5% in 1816-1820 (mean 50.6%;

distance to Fresnes is not significantly correlated with departmental differences in numeracy as measured by the Whipple index over the 1675-1700, 1705-1730 and 1675-1730 periods (Crayen and Baten, 2010).

Furthermore, anecdotal evidence suggests that the standard living in Flanders, the province of the French kingdom prior to 1789 which encompassed Fresnes-sur-Escaut, was nearly identical to that of the rest of France. When proxying standards of living by height (Komlos, 2005), we find in Appendix Figure H.1 that the average height of French army soldiers from Flanders over the 1700-65 period was not different from that of the soldiers from other parts of France.[15]

3.1.2   Wheat price shock and the adoption of steam engine in 1839-1847

The second component of the identification strategy is motivated by the hypothesis that, while the potential exposure to the steam engine would depend on the distance from Fresnes-sur-Escaut, the intensity in the adoption of this industrial technology would depend on the profitability of the industrial sector relative to the agricultural sector. Thus the analysis exploits cross-departmental variations in the net increase in wheat prices from their previous trends before the 1839-1847 survey to identify market conditions which would be conducive for a transition from agriculture production to industrial production and therefore for the adoption of the steam engine. In particular, by exploiting the transitory net increase in wheat prices from their previous trend, the analysis captures the diminished transition to industrial production associated with a temporary rise in the relative

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std. dev. 22.1%). In other words, the Nord department was the 67th most literate department in 1686-1690, 27th in 1786-1790 and 33rd in 1816-1820 (out of 76, 79 and 78 for which we have data in those respective years).

[15]There are well-known concerns that the height of soldiers is usually not representative of the height of the general population (e.g. Baten, 2000) but such selection bias is unlikely to explain the height of soldiers originating from Flanders as opposed to the rest of France.

prices of agricultural goods, holding constant the a-priori ambiguous long-term effect of agricultural productivity on the development of the industrial sector.[16]

The net increase in wheat prices captures the underlying regional deviations in climatic conditions from their previous trend and their effect on the reduction in wheat yield and hence, on the rise in wheat prices. Nevertheless, as will become apparent from the analysis reported in Table 3, and as will be discussed in this subsection, the net increase in wheat prices is a stronger predictor of the adoption of steam engines than observed measures of the underlying climatic conditions, plausibly due to intricate non-linear effects of climatic conditions on the net increase in wheat prices. Hence, the net increase in wheat prices, rather than its underlying climatic conditions will serve as the second instrumental variable in the analysis.

Using the data collected by Labrousse *et al.* (1970), we denote $\tilde{P}_{i,1834-1838}$ the standardized net increase in wheat prices in 1834-1838, i.e., during the five-year period which preceded the 1839-1847 industrial survey, from their recent trend as captured by the previous 15-year period

$$\tilde{P}_{i,1834-1838} \equiv \frac{\mu_{i,1834-1838} - \mu_{i,1819-1833}}{\sigma_{i,1819-1833}} \tag{1}$$

where $\mu_{i,1834-1838}$ is the average wheat price in department i over the 1834-1838 period, $\mu_{i,1819-1833}$ is the average wheat price in department i over the baseline period, 1819-1833, and $\sigma_{i,1819-1833}$ is the standard deviation of wheat prices in each year in department i computed over the 1819-1833 baseline period. Appendix Figure A.5 graphs the net increase in the standardized wheat price

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[16]The results are unlikely to be driven by the ability of the northern departments to import wheat from neighboring countries more easily than the departments on the eastern or southern borders. Moreover, wheat was grown throughout most of the French territory. In fact, the 1852 agricultural survey, which is the survey that is closest in time to the 1839-1847 industrial survey, suggests that wheat culture covered 13% of the then French territory. However, yields were very different across the country. The departments in the North of France were among those with the highest yield along with those around Paris and the departments in the South-West of France in the Garonne valley. Conversely, the lowest yields were in the mountainous zones of southern France, with the exception of the Ille-et-Vilaine and Haute-Marne departments. Namely, the arrondissement of Valenciennes in the Nord department had the highest yield (30hl/ha) while the arrondissement of Castellane in the southern Basses-Alpes department had the lowest yield (6.3hl/ha).

Table 3. *The determinants of the adoption of the steam engine in 1839-1847*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
	Number of Steam Engines			Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.337*** [0.326]	-1.309*** [0.329]	-1.312*** [0.331]	
Distance to Fresnes		-0.702*** [0.243]	-0.716*** [0.261]	
Squared Rainfall Standardized Deviation 1834-1838 (baseline 1819-1833)			0.0405 [0.194]	0.0657 [0.0447]
Geographic Characteristics	No	Yes	Yes	Yes
Institutional Characteristics	No	Yes	Yes	Yes
Adjusted R2	0.134	0.580	0.574	0.386
Observations	85	85	85	85

Note: This table establishes that the first stage of our estimation strategy where we relate the number of steam engines in 1839-1847 to the distance from Fresnes-sur-Escaut and the standardized net increase in wheat prices in 1834-1838 is robust to accounting for rainfall in 1834-1838. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department/arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

in 1834-1838 across the French departments as formulated in Equation 1, using 1819-1833 as the baseline period.

In line with the proposed hypothesis, the distribution of steam engines across French departments in the 1839-1847 industrial survey is negatively associated with the transitory cross-departmental standardized net increase in wheat prices from their historical trend. As reported in Column (1) of Table 3, unconditionally, there exists a highly significant negative association between the use in the steam engine in 1839-1847 across French departments and the standardized net increase in wheat prices over the period 1834-1838 from the historical trend (Appendix Table B.5 shows the results with the full set of controls). Furthermore Columns (2) and (3) show that this highly significant negative association is not weakened when the distance to Fresnes and the control variables are added.[17]

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[17]The interaction variable between the distance to Fresnes and the standardized net increase in wheat prices during the 1834-1838 period is insignificant. Note that the correlation coefficient between these two instruments is 0.54.

In particular, as derived from Column (3) of Table 3, a one-unit increase in the standardized net increase in wheat prices is associated with a 1.312-point decrease in the log of the number of steam engines in a department. As such, in comparison to a department at the 25th percentile of the net increase in wheat prices (-0.72), a department at the 75th percentile (-0.14), will have 0.47 fewer steam engines. Furthermore, a 100-km increase in the distance from Fresnes-sur-Escaut is associated with a 0.716 point decline in the log of the number of steam engines in a given department, relative to a sample mean of 1.47. Hence, in comparison to a department at the 25th percentile of the distance from Fresnes-sur-Escaut (i.e., 327 km), a department located at the 75th percentile (i.e., 659 km from Fresnes-sur-Escaut) will be expected to have 10.77 fewer steam engines (relative to a sample mean of 29.2 and a standard deviation of 66.1). Thus, while the diffusion of the steam engine as well the transition from agriculture to industry contributed to the adoption of steam engines, the effect of the gradual diffusion of steam engines from the North of France to the rest of the country was larger than the impact of the net rise in wheat prices on the pace of transition of French regions from agriculture to industry in the 19th century.

It might be hypothesized that the net increase in wheat prices captures the underlying deviations of climatic conditions in each department from their long-term trend and their effect of these changes on the reduction in wheat output and thus, on the rise in wheat prices. Indeed, rainfall deviations in 1834-1838 from their long-run trend are indeed positively correlated but insignificantly correlated with the net increase in steam engines in Column (3) and with wheat prices in Column (4) of Table 3.[18] These findings suggest that while climatic deviations from their long-run trend is plausibly the

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[18]We defined the squared deviation in rainfall as $r_{i,1834-1838} \equiv (m_{i,1834-1838} - m_{i,1819-1833})/s_{i,1819-1833}$ where $m_{i,1834-1838}$ is the average rainfall in department i over the 1834-1838 period, $m_{i,1819-1833}$ is the average rainfall in department i over the baseline period, 1819-1833, and $s_{i,1819-1833}$ is the standard deviation of rainfall in each year in department i computed over the 1819-1833 baseline period.

underlying cause of the net increase in wheat prices, their effect on steam engines is rather intricate and cannot be captured by climatic measures.

It should be noted that the negative association between the net increase in wheat prices and the number of steam engines could not reflect reverse causality from the number of engines to the net increase in wheat prices. In particular, an increase in the demand for industrial products, and hence for steam engines, would have generated a reallocation of labor from agriculture to industry, bringing about a decline in agricultural output and an increase in wheat prices. Hence, unlike the observed negative association between the net increase in wheat prices and the number of steam engines, reverse causality would result in a positive association. In fact, by using data on the 355 arrondissements from the 1852 Agricultural Survey on the share of day agricultural laborers in the population, Appendix Table B.6 establishes that the standardized net increase in wheat prices had a positive and significant effect on the share of day agricultural laborers in the population in 1852, as opposed to the negative one that labor reallocation from agriculture to industry would generate.

In addition, Appendix Table B.7 establishes the robustness of the impact of the net increase in wheat prices during the 1834-1838 period from the historical trends in 1819-1833 (Column (1)) to alternative baseline period: 1809-1833 (Column (2)), 1814-1833 (Column (3)) and 1824-1833 (Column (4)). The instruments clear the over-identification J-test in all specifications. Appendix Table B.7 also suggests that considering the strength of the instrumental variables, the desirable reference period at the department level for the standardized wheat price deviation over the 1834-1838 period is 1819-1833, where the F-statistic is 16.66. Further falsification tests reported in Table B.8 suggest that standardized earlier net increases in prices (i.e., during the five-year time periods, 1824-1828 and 1829-1833) and standardized net increases in prices after the conclusion of the survey

(i.e., during the five-year time periods, 1848-1852 and 1853-1857), are not significantly associated with the adoption of steam engines in 1839-1847.[19]

Finally, the significant association between the number of steam engines and the two instruments is robust to accounting for an additional set of confounding demographic and economic characteristics which, as discussed in Appendix C, may have contributed to the relationship between industrialization and economic development. These confounding factors (i.e., the distance to London, the presence of raw material, measures of early economic integration, measures of population and early urbanization, the past level of fertility, early literacy rates and the upper tail of the human capital distribution in the 18th century) 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 as established in Appendix Table C.1.

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 number of steam engines in each department/arrondissement in 1839-1847 and measures of human capital formation at different points in time;

$$Y_{it} = \alpha + \beta E_i + \boldsymbol{X'_i}\omega + \varepsilon_{it}, \tag{2}$$

where Y_{it} represents a measure of human capital in department/arrondissement i in year t, E_i is the log of the number of steam engines in department/arrondissement i in 1839-1847, $\boldsymbol{X'_i}$

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[19]Additional regressions indicate that the number of steam engines in 1839-1847 is not significantly correlated with the net increase in yearly wheat prices between 1839 and 1847, suggesting that a substantial part of the 1839-1847 survey was carried out in the 1839-1841 period, in line with the historical evidence discussed above in Section 2.

is a vector of geographical, institutional and pre-industrial economic characteristics of department/arrondissement i and ϵ_{it} is an i.i.d. error term for department/arrondissement i in year t.

In the first stage, E_i, the log of the number of steam engines in department/arrondissement i in 1839-1847 is instrumented by the aerial distance (in kilometers) between Fresnes-sur-Escaut and the administrative center of department/arrondissement i, D_i, as well as by the standardized net increase in wheat prices over the 1834-1838 period in department i, $\tilde{P}_{i,1834-1838}$ (as defined in Eq. (1));

$$E_i = \delta_1 D_i + \delta_2 \tilde{P}_{i,1834-1838} + \boldsymbol{X_i'}\delta_3 + \eta_i, \tag{3}$$

where $\boldsymbol{X_i'}$ is the same vector of geographical, institutional and pre-industrial economic characteristics of department/arrondissement i used in the second stage, and η_i is an error term for department/arrondissement i.

4   Results: Industrialization and Human Capital Formation

The study examines the effect of the number of steam engines in the 1839-1847 period on human capital formation. In line with the proposed hypothesis, Tables 4, 5 and 6 show that the early phase of the industrialization process was conducive to human capital accumulation (Appendix Tables D.1, D.2 and D.3 display the full set of control variables). Furthermore, based on Oster's β (Oster, 2019), these tables establish that the estimated value of our main coefficient is rather stable if unobservables were as correlated with the number of steam engines as the observables.

Moreover, several tables of results establish the robustness of our main regressions. First, Appendix Tables Appendix Tables E.1, E.2 and E.3 establish the robustness of the results for

the use the Distance to Sea and Distance to Border variables, instead of the Maritime Department/Arrondissement and Border Department/Arrondissement Dummies as control variables. Second, as eastblished in Appendix Tables F.1-F.12 using Colella *et al.* (2019)'s approach the resutls remains robust to accounting for spatial autocorrelation. Finally, in Appendix Tables C.2-C.18, we examine the robustness of the main results to the inclusion of additional confounding geographical, demographic, institutional and pre-industrial characteristics, which may have contributed to the relationship between industrialization and economic development. These confounding factors could be viewed as endogenous to the adoption of the steam engine and are thus not part of the baseline analysis. These are the distance to London, the presence of raw material, measures of early economic integration, measures of population and early urbanization, the past level of fertility, early literacy rates, primary schooling in 1833 as well as the presence of universities in 1700 and the upper tail of the human capital distribution in the 18th century.

4.1 The Effect of Industrialization on School Enrollment

To assess the effect of industrialization on school enrollment, we focus on the share of pupils enrolled in primary school out of the population age 5-15 in each department in 1840 and on the share of middle- and high-school pupils out of the population in each arrondissement in 1842.

4.1.1 Pupils in Primary Schools

The effect of industrialization on the share of pupils enrolled in primary school out of the population age 5-15 in each department in 1840 is reported in Columns (1)-(4) of Table 4. The unconditional OLS relationship between the number of steam engines used in industrial production in 1839-1847 and the share of pupils in 1840 is positive and significant (Column (1)). Furthermore, in the

Table 4. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
	Share of Primary School Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122***	0.137***	0.131***	0.304***	0.000173***	0.0002**	0.0002**	-0.0005
	[0.0369]	[0.0436]	[0.0468]	[0.0818]	[5.83e-05]	[8.21e-05]	[7.74e-05]	[0.0004]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
Oster β		0.170	0.144			0.004	0.0003	
Adjusted R2	0.091	0.428	0.454		0.027	0.026	0.084	
Observations	85	85	85	85	355	355	355	355
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines							
Distance to Fresnes				-0.702***				-0.214*
				[0.243]				[0.122]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-1.309***				-0.455***
				[0.329]				[0.113]
F-stat				16.661				9.613
Prob J-Stat				0.507				0.255
	Reduced Form: the dependent variable is							
	Share of Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Distance to Fresnes				-0.276***				-6.26e-06
				[0.103]				[0.0001]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-0.317**				0.0005**
				[0.148]				[0.0002]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

regressions in Columns (2)-(3) where we account for the exogenous geographical, institutional and pre-industrial factors discussed above in Section 2, the OLS estimates are rather stable and are largely unaffected by the inclusion of these variables.

The IV estimate in Columns (4) Table 4 suggests that the number of steam engines had a positive and significant impact on the share of pupils enrolled in the primary schools of each department in 1840, accounting for the confounding effects of geographical, institutional and pre-industrial

characteristics.[20] This positive and significant effect of industrialization on the share of pupils in 1840 in the IV regressions is consistent with the outcome of the reduced form regressions reported in the lower panel of Table 4, where the distance to Fresnes-sur-Escaut and the standardized net increase in wheat prices in 1834-1838 are negatively and significantly associated the share of pupils in 1840. Overall, the IV estimate in Column (4) of Table 4 suggests that a one-percent increase in the number of steam engines in a department increased the share of pupils enrolled in the primary schools in 1840 by 30.4% (relative to a mean of 49.1% and a standard deviation of 23.8%).

4.1.2   Pupils in Middle- and High-Schools

The effect of industrialization on the share of middle- and high-school pupils out of the population in each arrondissement in 1842 is reported in Columns (5)-(8) of Table 4. The relationship between the number of steam engines used in industrial production in 1839-1847 and the share of middle- and high-school pupils in 1842 is positive and significant in all the OLS specifications in Columns (5)-(7) which progressively account for geographical, institutional and pre-industrial characteristics.

However the IV estimate in Column (8) in Table 4 shows that the number of steam engines in 1839-1847 had no significant impact on the share of middle- and high-school pupils in each arrondissement in 1842, accounting for the confounding effects of geographical, institutional and pre-industrial characteristics. A possible interpretation of this insignificant IV result is that the coefficients in the OLS regressions are significant because of an omitted variable bias, whereby richer areas had more engines and more middle- and high-school pupils. More generally, this IV regression result suggests that industrialization in the first half of the 19th century did not provide incentives to invest in human capital beyond acquiring basic literacy skills.

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[20]In Table 4, as in the other Tables in this section, the IV estimates of the effect of the number of steam engines are larger than the OLS coefficients, possibly reflecting measurement error in the number of steam engines within the 1839-1847 survey (Chanut *et al.*, 2000).

4.2   The Effect of Industrialization on Literacy

This section explores the impact of industrialization on two measures of literacy. It first focuses on the share of literate conscripts at the level of the department, then with individual data of brides and grooms who signed their wedding licenses.

4.2.1   Literate conscripts

The relationship between industrialization and literacy, as captured by the share of army conscripts born between 1839 and 1848 who could read and write, is presented in Columns (1)-(4) of Table 5. In Column (1), unconditionally, the number of steam engines in 1839-1847 has a significant positive association with the share of literate conscripts. This association remains positive in all but one of the OLS regressions in Columns (2)-(3) where the confounding effects of exogenous geographical, institutional and pre-industrial factors are progressively included.

Moreover, in the IV regression in Column (4) of Table 5, the effect of industrialization on the share of literate conscripts is found to be positive and significant. The IV estimate indicates that a one-percent increase in the number of steam engines in a department in 1839-1847 increased the share of literate conscripts born between 1839 and 1848 by 11.6% (relative to a sample mean of 74% and a standard deviation of 15%). In addition, this positive and significant effect of industrialization on the share of literate conscripts born between 1839 and 1848 in the IV regression is corroborated by the result of the reduced form regressions reported in the lower panel of Table 5, where the distance to Fresnes and the net increase in wheat prices in 1834-1838 are negatively and significantly associated with the share of literate conscripts born between 1839 and 1848.

Table 5. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461** [0.0223]	0.0364 [0.0220]	0.0401** [0.0200]	0.116*** [0.0346]	0.0452*** [0.00677]	0.0314*** [0.00689]	0.139*** [0.0167]
Male					0.000492 [0.0112]	-0.00159 [0.0111]	0.00369 [0.0118]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
Oster β		-0.025	0.037		0.047	0.022	
Adjusted R2	0.046	0.289	0.396		0.024	0.048	
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines						
Distance to Fresnes				-0.702*** [0.243]			-0.475*** [0.0782]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-1.309*** [0.329]			-1.165*** [0.131]
F-stat				16.661			118.814
Prob J-Stat				0.530			0.030
	Reduced Form: the dependent variable is						
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Distance to Fresnes				-0.107** [0.0461]			-0.0334*** [0.0127]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-0.119* [0.0621]			-0.219*** [0.0242]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

4.2.2   Wedding License Signatures

The relationship between industrialization and literacy, as proxied by the ability of individuals born in a department between 1839 and 1848 to sign their wedding license (as opposed to marking it with a cross) is shown in Columns (5)-(7) of Table 5. In all the OLS and IV regressions, the number of steam engines in 1839-1847 has a significant and positive effect on the ability of spouses to sign their wedding license, controlling for their gender as well as geographical, institutional and pre-industrial factors. This positive and significant effect of industrialization on the ability of spouses born between 1839 and 1848 to sign their wedding license in the IV regression is consistent with the result of the reduced form regressions reported in the lower panel of Table 5, where the distance to Fresnes and the standardized net increase in wheat prices in 1834-1838 are negatively and significantly associated with each individual's ability to sign his/her wedding license between 1839 and 1848. Furthermore, we note that the qualitative variable which singles out men is not significant in any regression, suggesting that there is no difference in the literacy level of men and women born in each department. Overall, the IV estimate in Column (7) of Table 5 indicates that a one-percent increase in the number of steam engines in a department in 1839-1847 increased the probability that a groom or bride would sign his/her wedding license by 13.9% (relative to sample mean of 71.3% and a standard deviation of 45.3%).

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4.3   The Effect of Industrialization on Alternative Measures of Human Capital: Teachers and Public Spending on Education

This section explores the robustness of the baseline analysis by focusing on two indirect proxies of human capital formation, i.e., the number of primary school teachers and public expenditures

Table 6. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period.*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.190***	0.320***	0.129***	0.125***	0.137***	0.266***	0.270**	0.148*	0.191**	0.424***	-0.921***	-0.708***	-0.654***	-0.896***
	[0.0329]	[0.0357]	[0.0387]	[0.0873]	[0.0255]	[0.0316]	[0.0316]	[0.0631]	[0.102]	[0.0855]	[0.0796]	[0.122]	[0.115]	[0.180]	[0.193]	[0.319]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
Oster β		0.397	0.242			-1.297	0.168			-0.538	0.086			0.576	0.095	
Adjusted R2	0.187	0.381	0.431		0.232	0.305	0.370		0.113	0.276	0.422		0.292	0.354	0.363	
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines															
Distance to Fresnes				-0.702***				-0.702***				-0.702***				-0.702***
				[0.243]				[0.243]				[0.243]				[0.243]
Net Increase in Wheat Prices in 1834-1838				-1.309***				-1.309***				-1.309***				-1.309***
(baseline 1819-1833)				[0.329]				[0.329]				[0.329]				[0.329]
F-stat				16.661				16.661				16.661				16.661
Prob J-Stat				0.320				0.463				0.822				0.001
	Reduced Form: the dependent variable is															
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Distance to Fresnes				-0.296***				-0.139*				-0.139*				-0.139*
				[0.0823]				[0.0760]				[0.0760]				[0.0760]
Net Increase in Wheat Prices in 1834-1838				-0.328**				-0.409***				-0.409***				-0.409***
(baseline 1819-1833)				[0.163]				[0.121]				[0.121]				[0.121]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

on primary school education. As we discussed in Section 2, these variables are slightly imprecise measures of human capital formation since they may reflect other factors than the demand for education, e.g., the lobbying efforts of local interest groups.

4.3.1 Primary School Teachers

The relationship between industrialization and the number of primary school teachers in each department in 1840 is presented in Column (1)-(4) of Table 6. As shown in Column (1) of Table 6, unconditionally, the number of steam engines in 1839-1847 had a positive and significant association at the 1% level with the number of teachers in 1840. The OLS relationship remains positive, mostly

of the same magnitude and with the same level of statistical significance, once we account for the confounding effects of exogenous geographical factors, institutional factors and pre-industrial characteristics in Columns (2) and (3).

Moreover, mitigating the effect of omitted variables on the observed relationship, the IV estimate in Column (4) in Table 6 suggests that the number of steam engines in 1839-1847 had a positive, highly significant and quantitatively large impact on the number of teachers in 1840: a one-percent increase in the number of steam engines in a department in 1839-1847 increased the number of primary school teachers by 32.0% in 1840. This positive and significant effect of industrialization on the number of primary school teachers in 1840 in the IV regression is corroborated by the outcome of reduced form regression reported in the lower panel of Table 6 where the distance to Fresnes and the standardized net increase in wheat prices in 1834-1838 are negatively and significantly associated with the number of teachers.

4.3.2 Public Spending on Primary Schooling

Columns (5)-(16) of Table 6 examines the effect of industrialization on total public expenditures on primary schooling per inhabitant over the 1855-1863 period. The OLS and IV regressions distinguish between the expenditures of the three tiers of the French government that funded primary schooling, i.e., the communes in Columns (5)-(8), the departments in Columns (9)-(12) and the central state in Columns (13)-(16).

The OLS and IV regressions in Columns (5)-(16) of Table 6 indicate a positive and significant effect of industrialization on public spending per inhabitant by the communes and the departments, but a negative and significant effect on spending by central state. These results are thus in line with the historical evidence that the French central state sought to balance spending on education

undertaken by local governments, not out of benevolence but because of ideological reasons (see, e.g., Mayeur (2003), as well as our discussion in the Appendix). Overall, Table 6 shows that local governments in industrialized areas devoted more funds to primary schooling and is in line with the other results of this study which establish that industrialization and human capital formation were complementary factors during the early phase of the industrial revolution.

5   Concluding Remarks

The research explores the effect of industrialization on human capital formation. Exploiting exogenous regional variations in the adoption of steam engines across France, the study establishes that in contrast to conventional wisdom which views early industrialization as a predominantly deskilling process, the industrial revolution was conducive for human capital formation, generating broad increases in literacy rates and educational attainment.

In particular, the analysis suggests that a greater number of steam engines in a given administrative unit in 1839-1847 had a positive and significant effect on (i) the share of children in primary schools in 1840, (ii) the share of literate individuals among French army conscripts born between 1839 and 1848, (iii) the individual ability of men and women born in each department between 1839 and 1848 to sign their wedding license, (iv) the number of primary school teachers in 1840, and (v) public spending on primary schooling by local governments during the 1855-1863 period. The research thus lends further credence to the emerging view that human capital was instrumental in the process of industrialization, governing the pace of the transition from stagnation to growth and comparative economic development across the world.

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Supplementary Appendix for Online Publication

Appendix A. Descriptive Statistics and Figures
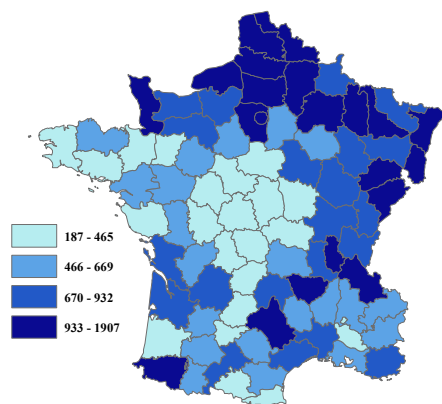
Figure A.1. *Number of teachers in 1840.*

Land Suitability.   Average Rainfall.   Average Temperature

Figure A.2. *Geographic characteristics of French departments*
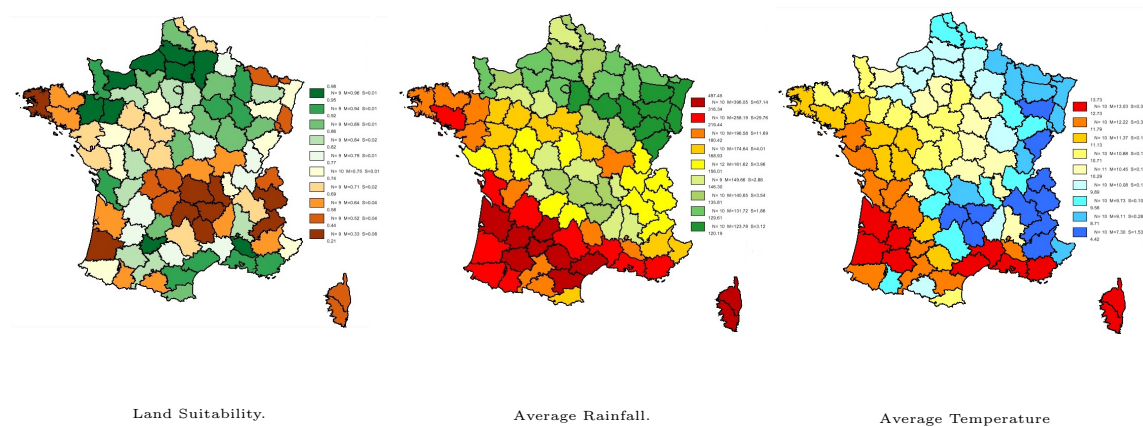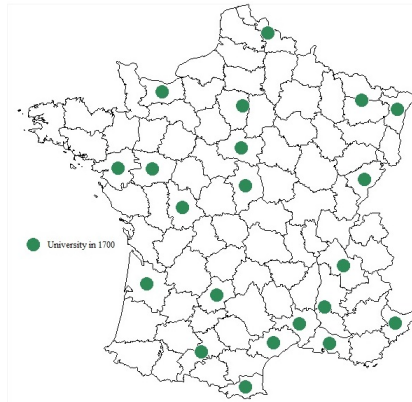
Figure A.3. *Universities in 1700.*
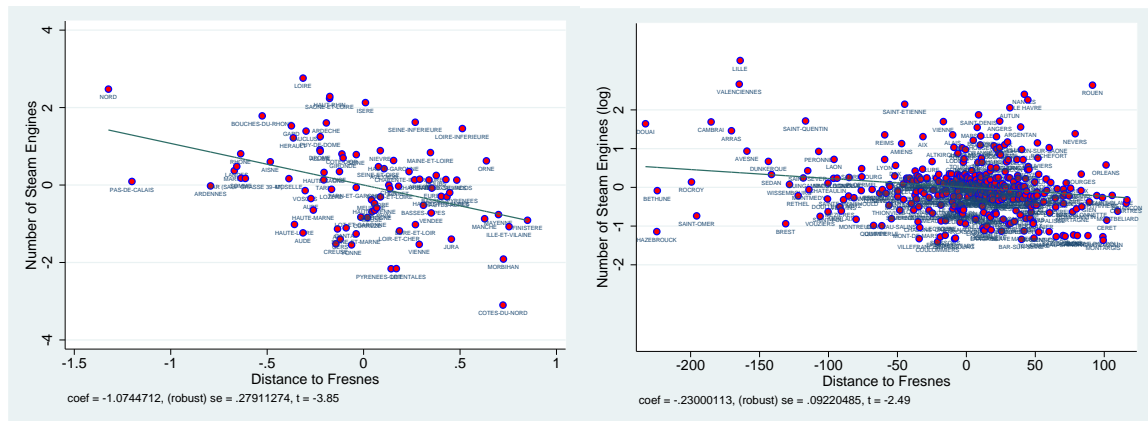
A. Department-level.   B. Arrondissement-level.

Figure A.4. *The effect of the distance from Fresnes-sur-Escaut on the number of steam engines in 1839-1847, conditional on geography and institutions.*

Note: These figures depict the partial regression line for the effect of the distance from Fresnes-sur-Escaut on the number of steam engines in each French department in 1839-1847, conditional on a range of geographical and institutional characteristics. Geographic characteristics include the department/arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. Panel A presents the relationship at the department level while Panel B reports the relationship at the arrondissement level. Thus, the x- and y-axes in Panels A and B plot the residuals obtained from regressing the number of steam engines and the distance from Fresnes-sur-Escaut with the aforementioned set of covariates.
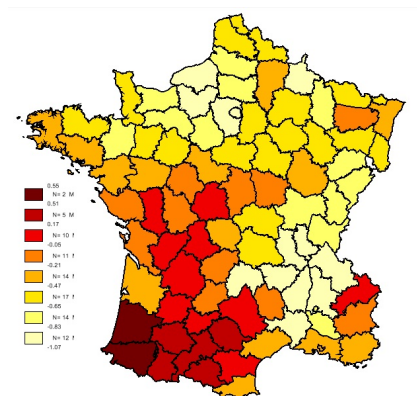
Figure A.5. *Standardized net increase in wheat prices, 1834-1838.*
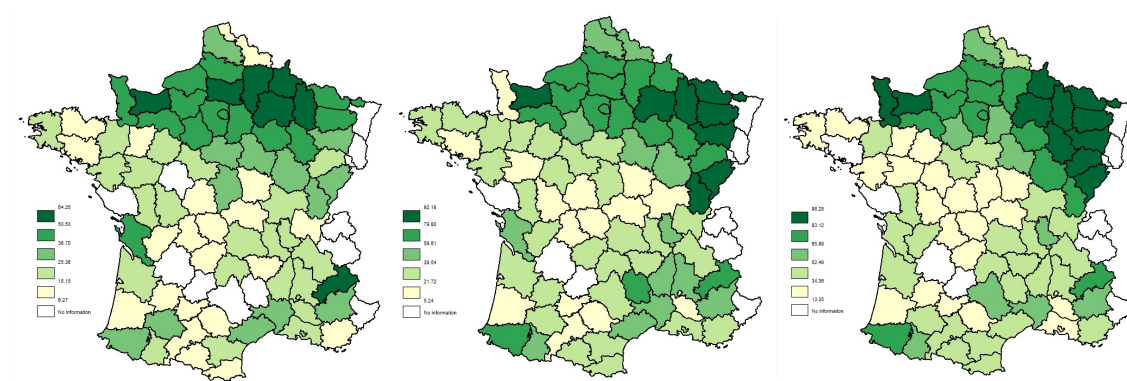
A. Literacy rates in 1686-1690. B. Literacy rates in 1786-1790. C. Literacy rates in 1816-1820.
Note: Literacy is captured by the share of grooms who signed their marriage license during each period.

Figure A.6. *Pre-industrial literacy rates of French departments*

Table A.1. *Descriptive Statistics: Department-Level Variables*

	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variables					
Pupils					
Share of Pupils Out of Population 5-15, 1840	85	0.49	0.24	0.15	1
Conscripts					
Share of Literate Conscripts born betwwen 1839 and 1848	85	0.74	0.15	0.41	0.98
Teachers					
Teachers, 1840	85	742	347	187	1907
Public Spending on Primary Schooling per Inhabitant, 1855-1863 (in French Francs)					
Commune Spending on Primary Schooling per Inhabitant, 1855-1863	85	0.65	0.24	0.07	1.27
Department Spending on Primary Schooling per Inhabitant, 1855-1863	85	0.08	0.05	0	0.33
Central State Spending on Primary Schooling per Inhabitant, 1855-1863	85	0.10	0.17	0	0.85
Explanatory Variables					
Number of Steam Engines	85	29.20	66.14	0	565
Average Rainfall	85	872.23	152.11	642.90	1289.24
Average Temperature	85	10.57	1.50	4.60	13.73
Latitude	85	46.59	2.12	42.60	50.49
Land Suitability	85	0.75	0.18	0.21	0.98
Share of Carboniferous Area	85	0.10	0.15	0	0.71
Maritime Department	85	0.26	0.44	0	1
Border Department	85	0.20	0.40	0	1
Distance to Paris	85	353.73	179.53	1	686.79
Paris and Suburbs	85	0.04	0.19	0	1
University 1700	85	0.24	0.43	0	1
Instrumental Variables					
Distance to Fresnes (100 km)	85	4.85	2.17	0.43	8.63
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	85	-0.42	0.38	-1.07	0.55
Variables for Robustness Analysis and Falsification Tests					
Early Economic and Human Development					
Encyclopedie subscribers	85	82.84	146.36	0	1078
Fertility, 1806	85	0.41	0.11	0.25	0.84
Grooms who Signed their Marriage License, 1686-1690	76	25.90	14.87	6.27	64.25
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	50.61	22.14	13.35	96.28
Population Density, 1801	84	0.75	1.55	0.19	13.17
Population Density, 1821	85	0.85	1.94	0.21	17.15
Iron Forges, 1789	85	2.25	8.95	0	52
Iron Forges, 1811	85	2.65	11.34	0	79
Presence of Iron Forges, 1789	85	0.11	0.31	0	1
Presence of Iron Forges, 1811	85	0.11	0.31	0	1
Market Integration during the French Revolution	84	134.68	107.44	21	732
Railroad Connection to Paris, 1860	85	.73	0.45	0	1
Share of department's territory covered by mines, 1837	85	0.008	0.015	0.00009	0.086
Share of department's territory covered by road network, 1837	85	1.57	0.97	0.05	5.47
Share of department's territory covered by water network, 1837	85	0.03	0.03	0	0.17
Trade cost shock	84	1.21	0.67	0.23	2.73
Squared Rainfall Increase 1834-1838 (baseline 1819-1833)					
Squared Increase 1834-1838 (baseline 1819-1833)	85	0.48	0.58	0	2.50
Wages, 1839-1847					
Average Male Wage, 1839-1847	85	194.40	34.02	145.60	342.57
Average Female Wage, 1839-1847	85	90.88	18.14	62.5	155.56
Average Child Wage, 1839-1847	85	64.44	13.81	40.96	111.27
Distance Variables					
Distance from London (100 km)	85	6.21	2.19	2.43	10.15
Distance from Lyon (100 km)	85	3.35	1.50	0.01	7.23
Distance from Marseille (100 km)	85	4.83	2.15	0.01	9.03
Distance from Mulhouse (100 km)	85	4.56	1.88	0.36	8.53
Distance from Rouen (100 km)	85	4.06	1.99	0.01	7.75
Distance to Border (100 km)	85	2.40	1.50	0.01	6.13
Distance to Sea (100 km)	85	1.94	1.57	0.01	6.91
Distance to University (100 km)	85	0.967	0.650	0	2.64
Distance from Fresnes (weeks of travel)	85	.471	0.185	0.045	0.862
Distance from Paris (weeks of travel)	85	0.389	0.168	0.003	0.693
Distance from Lyon (weeks of travel)	85	0.427	.229	0.029	0.960
Distance from Marseille (weeks of travel)	85	0.509	0.232	0.041	0.999
Distance from Mulhouse (weeks of travel)	85	0.641	0.292	0.012	1.126
Distance from Rouen (weeks of travel)	85	0.442	0.201	0.022	0.839
Number of Steam Engines per Inhabitant in 1841					
Number of Steam Engines per Inhabitant in 1841	85	0.00006	0.00007	0	0.0005
Wheat Prices					
Net Increase in Wheat Prices in 1829-1833 (baseline 1814-1828)	85	-0.53	0.21	-0.98	-0.10
Net Increase in Wheat Prices in 1824-1828 (baseline 1809-1823)	85	-0.69	0.28	-1.44	-0.25
Net Increase in Wheat Prices in 1839-1843 (baseline 1824-1838)	85	0.81	0.95	-0.11	7.80
Net Increase in Wheat Prices in 1844-1848 (baseline 1829-1843)	85	0.61	0.34	-0.21	1.23
Primary Schooling in 1833					
Communes with school	85	304.99	195.58	61	812
Total number of schools	85	392.93	221.72	92	1043
Total number of schools per inhabitant	85	0.0011	0.0005	0.0002	0.003

Table A.2. *Descriptive Statistics: Arrondissement-Level Variables*

	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variables					
Share of Middle- and High-School Pupils 1842	355	0.0015	0.0012	0	0.0058
Explanatory Variables					
Number of Steam Engines	355	6.97	20.45	0	284
Average Rainfall	355	866.19	148.55	642.90	1289.24
Average Temperature	355	10.60	1.42	4.60	13.73
Latitude	355	2.33	2.63	-4.61	7.83
Land Suitability	355	0.77	0.17	0.21	0.98
Share of Carboniferous Area	355	0.09	0.13	0.00	0.71
Maritime Department	355	0.29	0.46	0.00	1.00
Border Department	355	0.20	0.40	0.00	1.00
Distance to Paris	355	3.43	1.76	0.02	7.03
Paris and Suburbs	355	0.04	0.19	0.00	1.00
University	355	0.05	0.23	0.00	1.00
Instrumental Variables					
Distance to Fresnes (100 km)	355	4.68	2.19	0.42	8.79
Distance Variables					
Distance to Lyon (100 km)	355	3.53	1.55	0.08	9.89
Distance to Marseille (100 km)	355	5.09	2.17	-0.02	9.51
Distance to Mulhouse (100 km)	355	4.62	1.87	0.35	8.82
Distance to Rouen (100 km)	355	3.88	1.99	-0.02	8.05
Distance to Border (100 km)	355	2.41	1.58	0.01	7.15
Distance to Sea (100 km)	355	1.81	1.47	0.01	6.41
Distance to University (100 km)	355	1.12	0.62	0.01	3.79
Distance to Fresnes (weeks of travel)	351	0.46	0.19	0.04	0.90
Distance to Paris (weeks of travel)	351	0.38	0.17	0.00	0.70
Distance to Lyon (weeks of travel)	351	0.44	0.23	0.03	0.95
Distance to Marseille (weeks of travel)	351	0.53	0.23	0.04	1.01
Distance to Mulhouse (weeks of travel)	351	0.66	0.29	-0.01	1.20
Distance to Rouen (weeks of travel)	351	0.43	0.20	0.02	0.86
Agriculture 1852					
Share of Day Agricultural Laborers in Population	355	0.11	0.06	0.008	0.64
Payment-in-Kind 1852, Male Servant	355	22.97	43.70	0	450
Payment-in-Kind 1852, Female Servant	355	15.94	33.60	0	350

Table A.3. *Descriptive Statistics: Individual Characteristics*

	Obs.	Mean	Std. Dev.	Min.	Max.
Signature of Wedding License For Individuals Born between 1839 & 1848	7158	0.71	0.45	0	1
Male	7158	0.47	0.50	0	1

Table A.4. *Descriptive statistics: Steam Engines and Workers per Industrial Sector*

	Obs.	Mean	Std. Dev.	Min.	Max.
Steam Engines per Sector					
Ceramics	85	0.53	2.95	0	25
Chemistry	85	0.84	3.30	0	18
Clothing	85	0.15	0.81	0	6
Construction	85	0.07	0.40	0	3
Food	85	4.33	20.68	0	182
Furniture	85	0	0	0	0
Leather	85	0.04	0.24	0	2
Lighting	85	0.06	0.45	0	4
Luxury Goods	85	0.02	0.22	0	2
Metal objects	85	1.51	5.07	0	32
Metallurgy	85	1.79	5.87	0	42
Mines	85	2.68	11.53	0	81
Sciences & Arts	85	0.22	1.13	0	9
Textile	85	9.94	30.52	0	223
Transportation	85	0.31	2.09	0	18
Wood	85	0.26	1.23	0	9
Number of Steam Engines (total)	85	29.20	66.14	0	565
Workers per Sector					
Ceramics	85	406.02	682.28	0	4186
Chemistry	85	113.74	304.24	0	2073
Clothing	85	320.56	730.68	0	4000
Construction	85	251.54	309.22	0	1302
Food	85	1781.06	2445.28	0	15461
Furniture	85	37.35	221.92	0	2000
Leather	85	105.45	137.88	0	716
Lighting	85	18.67	39.81	0	215
Luxury Goods	85	16.04	69.18	0	576
Metal objects	85	815.78	2204.08	0	14382
Metallurgy	85	607.16	867.90	0	4119
Mines	85	788.15	1441.53	0	10580
Sciences & Arts	85	309.58	406.33	0	2140
Textile	85	8132.78	18793.75	0	128780
Transportation	85	98.98	344.48	0	2791
Wood	85	47.85	127.78	0	812
Workers (All Sectors)	85	13850.71	21289.12	540	135825

Appendix B. Robustness Analysis for First-Stage Regressions: Falsification tests & Arrondissement-Level Regressions

Table B.1. *The geographical diffusion of the steam engine*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.273***	-0.472**	-0.681***	-0.681***		-1.074***
	[0.0597]	[0.218]	[0.230]	[0.230]		[0.279]
Distance to Paris					-0.0268	0.628**
					[0.254]	[0.262]
Average Rainfall		0.0669	0.0543	0.0543	-0.204	-0.514
		[0.897]	[1.007]	[1.007]	[1.022]	[0.902]
Average Temperature		2.617***	2.251**	2.251**	1.316	2.652**
		[0.919]	[1.064]	[1.064]	[1.058]	[1.075]
Latitude		-7.922	-17.32	-17.32	10.22	-13.84
		[9.404]	[10.69]	[10.69]	[9.622]	[10.76]
Land Suitability		0.308	0.150	0.150	0.624	-0.0450
		[0.557]	[0.526]	[0.526]	[0.526]	[0.516]
Paris and Suburbs			-0.00573	-0.00573	0.315	0.540
			[0.604]	[0.604]	[0.662]	[0.663]
Share of Carboniferous Area			-0.329	-0.329	-0.515	-0.418
			[1.314]	[1.314]	[1.273]	[1.190]
Maritime Department			0.752**	0.752**	0.383	0.418
			[0.359]	[0.359]	[0.417]	[0.406]
Border Department			0.225	0.225	0.255	-0.219
			[0.377]	[0.377]	[0.451]	[0.404]
Mean Value of Dependent Variable	29.2	29.2	29.2	29.2	29.2	29.2
Adjusted R2	0.188	0.271	0.290	0.290	0.209	0.325
Observations	85	85	85	85	85	85

Note: This table presents the results of OLS regression analysis of the geographical diffusion of the steam engine across departments in France, as captured by the negative association between the number of steam engines used in each department in 1839-1847 and the distance (in kilometers) of each department from the location of the first commercial use of the steam engine in France (Fresnes-sur-Escaut). Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.2. *The geographical diffusion of the steam engine: arrondissement-level regressions*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.163***	-0.0717***	-0.0708***	-0.0708***		-0.230**
	[0.0292]	[0.0272]	[0.0271]	[0.0271]		[0.0922]
Distance to Paris					-0.0500*	0.219**
					[0.0302]	[0.110]
Average Rainfall		-0.529*	-0.730***	-0.730***	-0.864***	-0.875***
		[0.281]	[0.281]	[0.281]	[0.298]	[0.284]
Average Temperature		0.841**	0.756*	0.756*	0.399	0.735*
		[0.420]	[0.445]	[0.445]	[0.402]	[0.427]
Latitude		0.0574***	0.0670***	0.0670***	0.0695***	0.0441**
		[0.0200]	[0.0199]	[0.0199]	[0.0197]	[0.0221]
Land Suitability		-0.320	-0.155	-0.155	-0.0389	-0.165
		[0.203]	[0.217]	[0.217]	[0.203]	[0.213]
Paris and Suburbs			0.0218	0.0218	0.0116	0.246
			[0.265]	[0.265]	[0.269]	[0.277]
Share of Carboniferous Area			0.607*	0.607*	0.602*	0.671**
			[0.330]	[0.330]	[0.333]	[0.326]
Maritime Arrondissement			0.334**	0.334**	0.358***	0.235
			[0.136]	[0.136]	[0.136]	[0.158]
Border Arrondissement			0.433**	0.433**	0.467**	0.287
			[0.208]	[0.208]	[0.224]	[0.186]
Mean Value of Dependent Variable	6.97	6.97	6.97	6.97	6.97	6.97
Adjusted R2	0.090	0.591	0.607	0.607	0.601	0.613
Observations	355	355	355	355	355	355

Note: This table presents the results of OLS regression analysis of the geographical diffusion of the steam engine across departments in France, as captured by the negative association between the number of steam engines used in each arrondissement in 1839-1847 and the distance (in kilometers) of each arrondissement from the location of the first commercial use of the steam engine in France (Fresnes-sur-Escaut). Geographic characteristics include the arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.3. *The determinants of the diffusion of the steam engine: the insignificance of distances from other major French cities measured in travel weeks*

| | Panel A. Department-Level Regressions | | | | | |
| | (1) OLS | (2) OLS | (3) OLS | (4) OLS | (5) OLS | (6) OLS |
	Number of Steam Engines					
Distance from Fresnes (weeks of travel)	-2.858*** [0.680]	-3.828*** [1.117]	-2.772*** [0.661]	-3.077*** [0.756]	-2.834*** [0.741]	-2.944*** [0.823]
Distance from Paris (weeks of travel)		1.314 [1.242]				
Distance from Marseille (weeks of travel)			0.489 [0.686]			
Distance from Lyon (weeks of travel)				0.558 [0.700]		
Distance from Rouen (weeks of travel)					-0.0485 [0.738]	
Distance from Mulhouse (weeks of travel)						0.129 [0.531]
Mean Value of the Dependent Variable	29.2	29.2	29.2	29.2	29.2	29.2
Adjusted R^2	0.15	0.15	0.14	0.15	0.14	0.14
Observations	85	85	85	85	85	85

| | Panel B. Arrondissement-Level Regressions | | | | | |
| | (1) OLS | (2) OLS | (3) OLS | (4) OLS | (5) OLS | (6) OLS |
	Number of Steam Engines					
Distance to Fresnes (weeks of travel)	-1.791*** [0.344]	-2.519*** [0.862]	-1.794*** [0.517]	-1.827*** [0.598]	-1.860*** [0.571]	-1.719*** [0.647]
Distance to Paris (weeks of travel)		1.020 [.910]				
Distance to Marseille (weeks of travel)			-0.0252 [0.396]			
Distance to Lyon (weeks of travel)				0.0897 [0.429]		
Distance to Rouen (weeks of travel)					0.145 [0.496]	
Distance to Mulhouse (weeks of travel)						-0.105 [0.358]
Mean Value of the Dependent Variable	6.97	6.97	6.97	6.97	6.97	6.97
Adjusted R2	0.080	0.089	0.077	0.078	0.078	0.078
Observations	351	351	351	351	351	351

Note: This table establishes that the negative association between the number of steam engines used in the department/arrondissement in 1839-1847 and the distance of the department/arrondissement measured in travel weeks from the location of the first commercial use of the steam engine in France – Fresnes-sur-Escaut, is unaffected by distances from other major cities in France. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.4. *Orthogonality of distance from Fresnes-sur-Escaut and pre-industrial human capital*

	(1) OLS University 1700	(2) OLS Distance to University 1700	(3) OLS Literacy 1686-1690 Level	(4) Ordered Logit Literacy 1686-1690 Rank	(5) OLS Numeracy 1675-1700	(6) OLS Numeracy 1705-1730	(7) OLS Numeracy 1675-1730	(8) OLS University 1700	(9) OLS Distance to University 1700
Distance to Fresnes	-0.0088	17.30	-0.0206	0.556	0.0021	-0.0239	-0.008	0.0185	-5.043
	[0.105]	[17.07]	[0.0435]	[0.842]	[0.0178]	[0.0235]	[0.0142]	[0.0166]	[10.43]
Adjusted R2	0.035	0.095	0.500		-0.074	-0.033	-0.056	0.027	0.231
Pseudo R2				0.088					
Observations	85	85	76	76	84	84	84	355	355
Department-Level Regressions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Arrondissement-Level Regressions	No	No	No	No	No	No	No	Yes	Yes
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table establishes the orthogonality of the distance from the location of the first commercial use of the steam engine in France (Fresnes-sur-Escaut) to measures of pre-industrial human capital formation at the department-level (Columns 1-7) and arrondissement-level (Columns 8-9). The measures are the presence of a university (Columns 1 and 5), the distance between the main town (chef-lieu) of each department/arrondissement and the closest university (Columns 2 and 6), the literacy rate in 1686-1690 (Column 3) and the rank of each department in the distribution of literacy rates 1686-1690 (Column 4) as well as departmental differences in numeracy as measured by the Whipple index (Crayen and Baten, 2010). Geographic characteristics include the department/arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. The data on literacy rates in 1686-90 are only available at the department-level and observations are missing for some of the departments (Furet and Ozouf, 1977). Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.5. *The geographical diffusion of the steam engine in 1839-1847: the standardized net increase in wheat prices in 1834-1838, the distance from Fresnes-sur-Escaut & rainfall in 1834-1838*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
	Number of Steam Engines			Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.337***	-1.309***	-1.312***	
	[0.326]	[0.329]	[0.331]	
Distance to Fresnes		-0.702***	-0.716***	
		[0.243]	[0.261]	
Squared Rainfall Standardized Deviation 1834-1838			0.0405	0.0657
(baseline 1819-1833)			[0.194]	[0.0447]
Average Rainfall		-1.436*	-1.410	-0.126
		[0.837]	[0.858]	[0.315]
Average Temperature		1.931	1.908	1.245***
		[1.196]	[1.209]	[0.424]
Latitude		-15.25**	-15.48**	-3.295*
		[7.564]	[7.563]	[1.835]
Land Suitability		-0.772**	-0.761**	-0.488***
		[0.375]	[0.381]	[0.135]
Share of Carboniferous Area		-0.0951	-0.136	-0.366
		[0.672]	[0.745]	[0.336]
Maritime Department		0.627**	0.632**	-0.0795
		[0.306]	[0.308]	[0.103]
Border Department		0.313	0.310	0.312***
		[0.348]	[0.352]	[0.104]
Distance to Paris		0.345	0.360	-0.0126
		[0.233]	[0.260]	[0.0549]
Paris and Suburbs		0.0939	0.129	-0.245**
		[0.600]	[0.653]	[0.105]
Adjusted R2	0.134	0.580	0.574	0.386
Observations	85	85	85	85

Note: This table establishes that the first stage of our estimation strategy where we relate the number of steam engines in 1839-1847 to the distance from Fresnes-sur-Escaut and the standardized net increase in wheat prices in 1834-1838 is robust to accounting for rainfall in 1834-1838. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.6. *Standardized net increase in wheat prices in 1834-1838 & the persistence of agriculture in 1852*

	(1) OLS Share of Day Agricultural Laborers in Population 1852	(2) OLS Payment-in-Kind Male Servant 1852	(3) OLS Payment-in-Kind Female Servant 1852
Net Increase in Wheat Prices in 1834-1838	0.174*	0.793**	0.777**
(baseline 1819-1833)	[0.103]	[0.366]	[0.300]
Geographic Characteristics	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes
Adjusted R2	0.108	0.084	0.096
Clusters	85	85	85
Observations	355	355	355

Note: This table establishes that the standardized net increase in wheat prices in 1834-1838 led to increases in agricultural investments, as seen from increases in the share of agricultural day laborers in the population and higher in-kind payments for male and female servants in 1852. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the arrondissement's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.7. *Steam engine adoption in 1839-1847: the geographical diffusion of the steam engine and standardized net increase in wheat prices in 1834-1838 at the department level*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
	Number of Steam Engines			
Distance to Fresnes	-0.702***	-0.624**	-0.688***	-0.679**
	[0.243]	[0.249]	[0.246]	[0.259]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309***			
	[0.329]			
Net Increase in Wheat Prices in 1834-1838 (baseline 1809-1833)		-1.866***		
		[0.544]		
Net Increase in Wheat Prices in 1834-1838 (baseline 1814-1833)			-1.933***	
			[0.514]	
Net Increase in Wheat Prices in 1834-1838 (baseline 1824-1833)				-1.166***
				[0.386]
Average Rainfall	-1.436*	-1.783**	-1.573*	-1.459*
	[0.837]	[0.794]	[0.805]	[0.839]
Average Temperature	1.931	1.675	1.655	1.858
	[1.196]	[1.208]	[1.180]	[1.153]
Latitude	-15.25**	-8.705	-12.50	-14.19*
	[7.564]	[8.079]	[7.793]	[8.071]
Land Suitability	-0.772**	-0.575	-0.654*	-0.640*
	[0.375]	[0.395]	[0.382]	[0.372]
Share of Carboniferous Area	-0.0951	0.0554	-0.0294	-0.0685
	[0.672]	[0.675]	[0.678]	[0.684]
Maritime Department	0.627**	0.584*	0.592*	0.741**
	[0.306]	[0.316]	[0.307]	[0.312]
Border Department	0.313	0.236	0.243	0.265
	[0.348]	[0.341]	[0.340]	[0.349]
Distance to Paris	0.345	0.341	0.355	0.355
	[0.233]	[0.228]	[0.229]	[0.241]
Paris and Suburbs	0.0939	0.120	0.0417	0.177
	[0.600]	[0.612]	[0.608]	[0.650]
Mean Value of the Dependent Variable	29.2	29.2	29.2	29.2
F-stat	16.661	12.961	15.527	13.395
Prob J-Stat	0.320	0.552	0.441	0.431
Observations	85	85	85	85

Note: This table establishes the first stage of our estimation strategy where we relate the number of steam engines in 1839-1847 to the distance from Fresnes-sur-Escaut and the standardized net increase in wheat prices in 1834-1838. The relationship is shown to be robust to four baseline periods, i.e, 1819-1833, 1809-1833, 1814-1833 and 1824-1833. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.8. *The determinants of the adoption of the steam engine in 1839-1847: standardized net increase in wheat prices in 1834-1838*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS
	Number of Steam Engines				
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.337*** [0.326]	-0.916* [0.463]	-1.725** [0.670]	-1.139*** [0.353]	-1.280*** [0.349]
Net Increase in Wheat Prices in 1824-1828 (baseline 1809-1823)		0.994 [0.651]			
Net Increase in Wheat Prices in 1829-1833 (baseline 1814-1828)			0.801 [1.288]		
Net Increase in Wheat Prices in 1848-1852 (baseline 1833-1847)				0.473 [0.295]	
Net Increase in Wheat Prices in 1853-1857 (baseline 1838-1852)					-0.191 [0.329]
Mean Value of the Dependent Variable	29.2	29.2	29.2	29.2	29.2
Adjusted R^2	0.13	0.15	0.13	0.16	0.13
Observations	85	85	85	85	85

Note: This table relates the number of steam engines in 1839-1847 to the standardized net increase in wheat prices in 1834-1838 using the 1819-1833 period as a baseline. The relationship is shown to be robust to the inclusion of standardized net increases in wheat prices in other periods (1824-1828, 1829-1833, 1848-1852 & 1853-1857). The regressions account for a range of geographical and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments/arrondissements as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** indicates significance at the 1%-level, ** at the 5%-level, * at the 10%-level.

Appendix C. Robustness Analysis: Confounding Factors

This section examines the robustness of the baseline analysis to the inclusion of additional confounding geographical, demographic, institutional and pre-industrial characteristics, which may have contributed to the relationship between industrialization and economic development. These confounding factors could be viewed as endogenous to the adoption of the steam engine and are thus not part of the baseline analysis.

Table C.1 establishes that these confounding factors, which could be largely viewed as endogenous to the adoption of the steam engine, do not affect the qualitative results of the first stage of our empirical analysis.

In what follows, the analysis focuses on the potential impact of these confounding factors on the IV regressions in Section 4 where the dependent variables are the number of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840.

C.1. Distance from London

Given the early industrial use of the steam engine in England and the intensive economic relationship between France and England, human capital in French departments could have been affected by their proximity to England. However, as reported in Appendix Table C.2, accounting for the aerial distance from England has no qualitative impact on the estimated effect of industrialization on human capital.

Table C.1.   *The geographical diffusion of the steam engine: robustness analysis*

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
			Number of Steam Engines			
Distance to Fresnes	-0.696***	-0.696***	-0.641***	-0.642***	-0.623**	-0.685***
	[0.243]	[0.242]	[0.220]	[0.220]	[0.244]	[0.244]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.308***	-1.290***	-1.454***	-1.456***	-0.981***	-1.210***
	[0.339]	[0.334]	[0.325]	[0.325]	[0.349]	[0.351]
Population Density, 1801	0.121					
	[0.527]					
Population Density, 1821		0.153				
		[0.482]				
Iron Forges, 1789			0.218			
			[0.252]			
Presence of Iron Forges, 1789			-0.0110			
			[0.692]			
Iron Forges, 1811				0.214		
				[0.226]		
Presence of Iron Forges, 1811				-0.0129		
				[0.645]		
Market Integration during the French Revolution					0.405**	
					[0.154]	
Encyclopedie subscribers						0.0007
						[0.0009]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Mean Value of Dependent Variable	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.574	0.575	0.589	0.590	0.605	0.580
Observations	84	85	85	85	84	85

Note: This table establishes the robustness of the first stage of our estimation strategy where we relate the number of steam engines in 1839-1847 to the distance from Fresnes-sur-Escaut and the standardized net increase in wheat prices in 1834-1838 to the inclusion of population density in 1801 and 1821, the number and presence of iron forges in 1789 and 1811, market integration during the French Revolution and the number of Encyclopédie subscribers. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.2. *Industrialization and human capital formation, accounting for the distance between London and each department*

	(1)	(2)	(3)	(4)	(5)	(6)
	IV	IV	IV	IV	IV	IV
	Share of Pupils		Share of Literate Conscripts		Teachers	
	Out of Population 5-15, 1840		born between 1839 and 1848		1840	
Number of Steam Engines	0.304***	0.218**	0.116***	0.0843**	0.320***	0.372***
	[0.0818]	[0.0932]	[0.0346]	[0.0399]	[0.0873]	[0.105]
London		0.138*		0.0505		-0.0762
		[0.0746]		[0.0344]		[0.0603]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702***	-0.846***	-0.702***	-0.846***	-0.702***	-0.846***
	[0.243]	[0.283]	[0.243]	[0.283]	[0.243]	[0.283]
Net Increase in Wheat Prices in 1834-1838	-1.309***	-1.411***	-1.309***	-1.411***	-1.309***	-1.411***
(baseline 1819-1833)	[0.329]	[0.347]	[0.329]	[0.347]	[0.329]	[0.347]
F-stat	16.661	14.052	16.661	14.052	16.661	14.052
Prob J-Stat	0.507	0.732	0.530	0.721	0.320	0.243

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the distance between London and the capital (chef-lieu) of each department. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

C.2 The Presence of Raw Material

A. Forges in 1789.

B. Forges in 1811.

C. Area Covered by Mines in each department in 1837.

D. Market Integration in the 1790s.

Figure C.1. *Early economic development across French departments.*

The diffusion of the steam engine across French departments could have been impacted by the presence of raw material required for industrialization. Moreover the wealth generated by this raw material could have affected human capital. As was shown in the baseline regressions in Section 4,

Table C.3. *Industrialization and human capital formation, accounting for iron forges before 1815*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
	Share of Pupils Out of Population 5-15, 1840			Share of Literate Conscripts born between 1839 and 1848			Teachers 1840		
Number of Steam Engines	0.304*** [0.0818]	0.266*** [0.0614]	0.265*** [0.0613]	0.116*** [0.0346]	0.0984*** [0.0265]	0.0984*** [0.0265]	0.320*** [0.0873]	0.307*** [0.0830]	0.307*** [0.0829]
Iron Forges, 1789		-0.0665 [0.0910]			-0.0141 [0.0284]			0.0854 [0.139]	
Presence of Iron Forges, 1789		-0.423 [0.267]			-0.245** [0.107]			-0.422 [0.395]	
Iron Forges, 1811			-0.0693 [0.0834]			-0.0121 [0.0259]			0.0687 [0.131]
Presence of Iron Forges, 1811			-0.412 [0.254]			-0.250** [0.102]			-0.382 [0.375]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.491	0.74	0.74	0.74	742	742	742
Observations	85	85	85	85	85	85	85	85	85
First stage: the instrumented variable is Number of Steam Engines									
Distance to Fresnes	-0.702*** [0.243]	-0.641*** [0.220]	-0.642*** [0.220]	-0.702*** [0.243]	-0.641*** [0.220]	-0.642*** [0.220]	-0.702*** [0.243]	-0.641*** [0.220]	-0.642*** [0.220]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.454*** [0.325]	-1.456*** [0.325]	-1.309*** [0.329]	-1.454*** [0.325]	-1.456*** [0.325]	-1.309*** [0.329]	-1.454*** [0.325]	-1.456*** [0.325]
F-stat	16.661	18.991	18.997	16.661	18.991	18.997	16.661	18.991	18.997
Prob J-Stat	0.507	0.018	0.018	0.530	0.018	0.018	0.320	0.118	0.119

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the number and presence of iron forges in 1789 and 1811. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

the statistical impact of industrialization on human capital remains intact when one accounts for the share of carboniferous area in each department (Fernihough and O'Rourke, 2021). Nevertheless, the diffusion of the steam engine across France as well as human capital formation could have been affected by the early use of raw material required for industrialization. Nevertheless, the effect of industrialization on human capital in the first stages of the industrial revolution remains nearly intact, economically and statistically, when the number of iron forges in 1789 and 1811 (Panels A and B of Figure C.1) in each department (Woronoff, 1997) are accounted for in Table C.3 or when the area covered by coal mines in 1837 (Panel C of Figure C.1) in each department is taken into account in Table C.4.

Table C.4.   *Industrialization and human capital formation, accounting for mines in 1837*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304***	0.435***	0.116***	0.157***	0.320***	0.383***
	[0.0818]	[0.112]	[0.0346]	[0.0477]	[0.0873]	[0.127]
Share of department's territory		-0.0946***		-0.0299**		-0.0454
covered by mines, 1837		[0.0342]		[0.0148]		[0.0359]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702***	-0.530**	-0.702***	-0.530**	-0.702***	-0.530**
	[0.243]	[0.207]	[0.243]	[0.207]	[0.243]	[0.207]
Net Increase in Wheat Prices in 1834-1838	-1.309***	-1.020***	-1.309***	-1.020***	-1.309***	-1.020***
(baseline 1819-1833)	[0.329]	[0.317]	[0.329]	[0.317]	[0.329]	[0.317]
F-stat	16.661	12.278	16.661	12.278	16.661	12.278
Prob J-Stat	0.507	0.487	0.530	0.521	0.320	0.326

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the share of department's territory covered by mines in 1837. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.
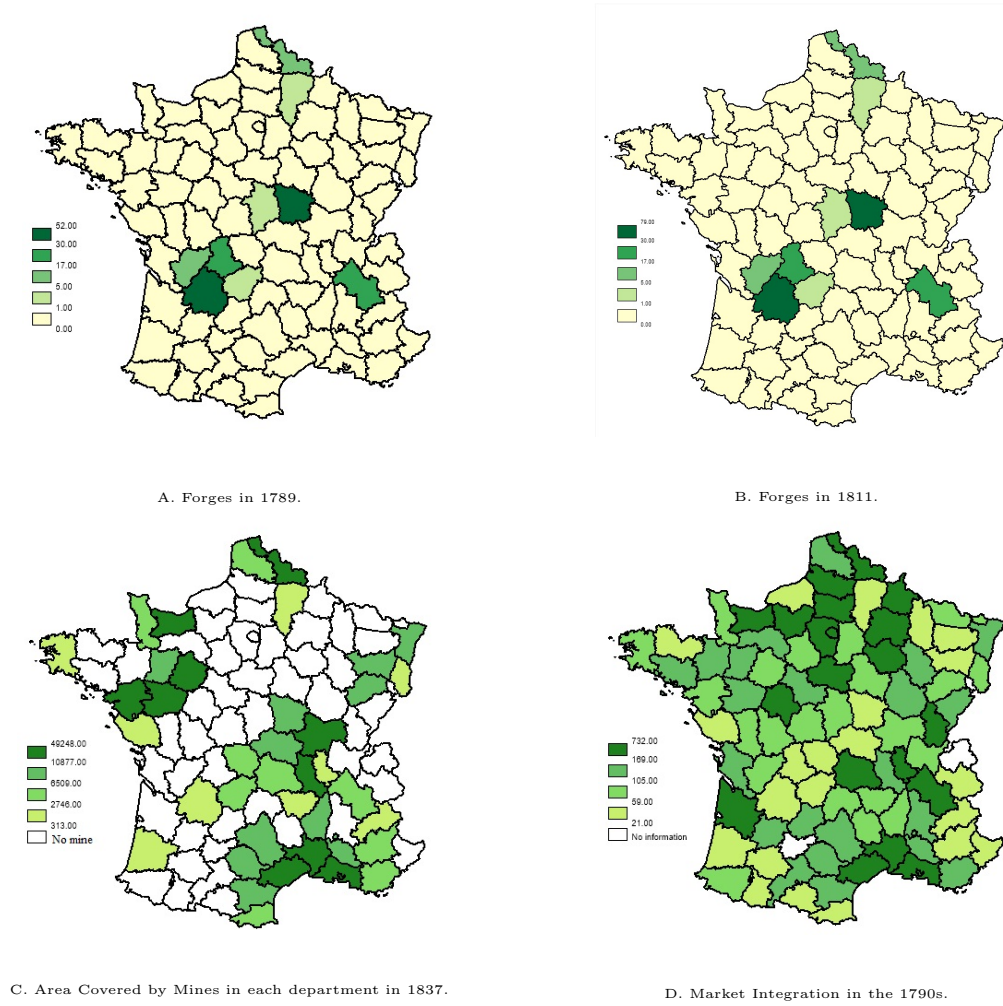
C.3. Early Economic Integration

Human capital formation and the number of steam engines across French departments could have been affected by the degree of economic integration of each department into France as a whole. However, Table C.5 establishes that the degree of early market integration of each department (depicted in Panel D of Figure C.1), as proxied by the number of firms which sold their products outside that home department in the 1790s (Daudin, 2010), has no qualitative impact on the effect of industrialization on human capital formation in the early phase of the industrial revolution. In addition, we find no impact of the trade cost associated with the Napoleonic blockade (Juhasz, 2018) on the relationship between industrialization and human capital accumulation. Moreover, as

Table C.5.   *Industrialization and human capital formation, accounting for market integration during the French Revolution*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304***	0.312***	0.116***	0.121***	0.320***	0.305***
	[0.0818]	[0.108]	[0.0346]	[0.0451]	[0.0873]	[0.111]
Market Integration during the French Revolution		-0.00551		-0.00961		0.0324
		[0.0959]		[0.0444]		[0.0932]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	84	85	84	85	84
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702***	-0.623**	-0.702***	-0.623**	-0.702***	-0.623**
	[0.243]	[0.244]	[0.243]	[0.244]	[0.243]	[0.244]
Net Increase in Wheat Prices in 1834-1838	-1.309***	-0.981***	-1.309***	-0.981***	-1.309***	-0.981***
(baseline 1819-1833)	[0.329]	[0.349]	[0.329]	[0.349]	[0.329]	[0.349]
F-stat	16.661	8.854	16.661	8.854	16.661	8.854
Prob J-Stat	0.507	0.544	0.530	0.537	0.320	0.252

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of Daudin (2010)'s measure of market integration during the French Revolution. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

reported in Table C.7, the effect of early industrialization on human capital formation is robust to the inclusion of the shares of the road and of water networks in each department's territory in 1837. Finally, in line with the historical evidence (see, e.g., Daudin *et al.* (2019) for a discussion), Table C.8 shows that the development of the railroad network in 1860, as proxied by railroad connection between each department's administrative center (*chef-lieu*) and Paris in 1860 (Caron, 1997), was neither positively and significanly correlated with measures of human capital before or after 1860, nor had a qualitative impact on the effect of industrialization on human capital formation.

Table C.6. *Industrialization and human capital formation, accounting for the trade cost associated with the Napoleonic blockade*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304***	0.250***	0.116***	0.0908**	0.320***	0.362***
	[0.0818]	[0.0891]	[0.0346]	[0.0372]	[0.0873]	[0.0988]
Trade cost shock		-0.188		-0.0816		0.142
		[0.119]		[0.0525]		[0.113]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	84	85	84	85	84
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702***	-0.808***	-0.702***	-0.808***	-0.702***	-0.808***
	[0.243]	[0.271]	[0.243]	[0.271]	[0.243]	[0.271]
Net Increase in Wheat Prices in 1834-1838	-1.309***	-1.377***	-1.309***	-1.377***	-1.309***	-1.377***
(baseline 1819-1833)	[0.329]	[0.336]	[0.329]	[0.336]	[0.329]	[0.336]
F-stat	16.661	17.067	16.661	17.067	16.661	17.067
Prob J-Stat	0.507	0.722	0.530	0.700	0.320	0.161

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the trade cost associated with the Napoleonic blockade (Juhasz, 2018). The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.7. *Industrialization and human capital formation, accounting for the share of the road and water networks in each department's territory in 1837*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV	(10) IV	(11) IV	(12) IV
	Share of Pupils Out of Population 5-15, 1840				Share of Literate Conscripts born between 1839 and 1848				Teachers 1840			
Number of Steam Engines	0.368*** [0.0755]	0.367*** [0.0740]	0.388*** [0.0903]	0.385*** [0.0886]	0.116*** [0.0346]	0.116*** [0.0346]	0.138*** [0.0375]	0.138*** [0.0377]	0.320*** [0.0873]	0.319*** [0.0841]	0.330*** [0.102]	0.324*** [0.0984]
Share of department's territory covered by road network, 1837		0.110 [0.0804]		0.102 [0.0828]		-0.00104 [0.0391]		-0.0109 [0.0422]		0.167** [0.0842]		0.165* [0.0871]
Share of department's territory covered by water network, 1837			-1.647 [2.363]	-1.402 [2.431]			-1.762 [1.219]	-1.789 [1.221]			-0.799 [2.203]	-0.404 [2.332]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.74	0.74	0.74	0.74	742	742	742	742
Observations	85	85	85	85	85	85	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines											
Distance to Fresnes	-0.702*** [0.243]	-0.703*** [0.243]	-0.633*** [0.232]	-0.632*** [0.230]	-0.702*** [0.243]	-0.703*** [0.243]	-0.633*** [0.232]	-0.632*** [0.230]	-0.702*** [0.243]	-0.703*** [0.243]	-0.633*** [0.232]	-0.632*** [0.230]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.307*** [0.333]	-1.174*** [0.312]	-1.168*** [0.317]	-1.309*** [0.329]	-1.307*** [0.333]	-1.174*** [0.312]	-1.168*** [0.317]	-1.309*** [0.329]	-1.307*** [0.333]	-1.174*** [0.312]	-1.168*** [0.317]
F-stat	16.661	16.466	13.834	13.614	16.661	16.466	13.834	13.614	16.661	16.466	13.834	13.614
Prob J-Stat	0.292	0.285	0.296	0.289	0.530	0.530	0.527	0.526	0.320	0.298	0.321	0.299

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the shares of the department's territory covered by the road and water networks in 1837. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.8. *Industrialization and human capital formation, accounting for railroad connection to Paris in 1860*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304*** [0.0818]	0.289*** [0.0842]	0.116*** [0.0346]	0.106*** [0.0334]	0.320*** [0.0873]	0.328*** [0.0909]
Railroad Connection to Paris, 1860		0.137 [0.129]		0.0898 [0.0587]		-0.0406 [0.118]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702*** [0.243]	-0.722*** [0.250]	-0.702*** [0.243]	-0.722*** [0.250]	-0.702*** [0.243]	-0.722*** [0.250]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.216*** [0.344]	-1.309*** [0.329]	-1.216*** [0.344]	-1.309*** [0.329]	-1.216*** [0.344]
F-stat	16.661	15.144	16.661	15.144	16.661	15.144
Prob J-Stat	0.507	0.310	0.530	0.253	0.320	0.371

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the shares of the department's territory covered by the road and water networks in 1837. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

C.4. Population Density and Early Urbanization

A. Population Density in 1801   B. Population Density in 1821.   C. Urban population in 1700 (in thousands)
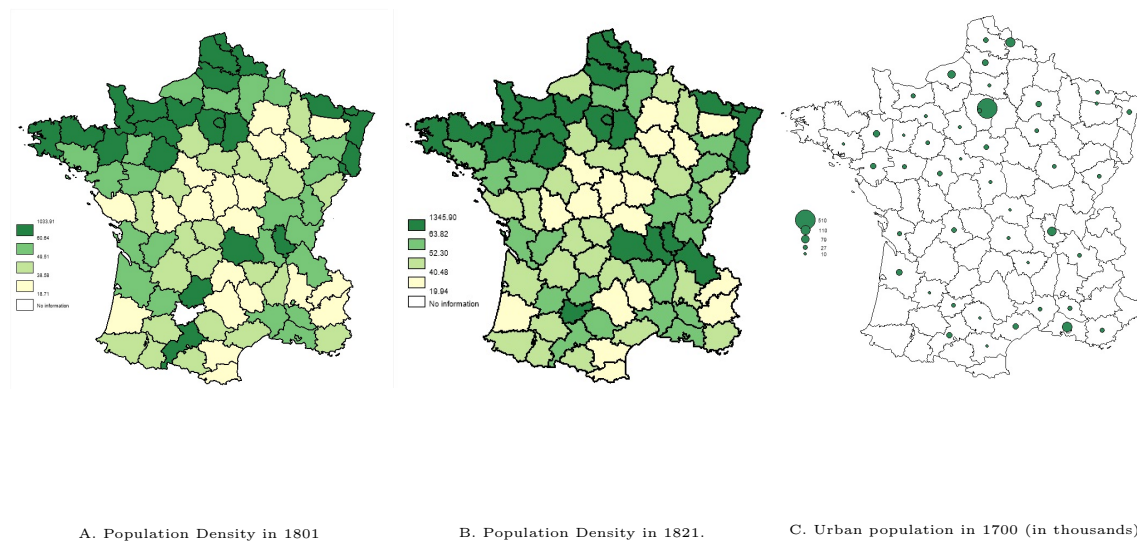
Figure C.2. *Population density and early urbanization*

In light of the historical evidence that steam engines were more likely to be located in urban centers (Rosenberg and Trajtenberg, 2004), it is plausible that the potentially endogenous level of population density could have been factors in the adoption of the steam engine and in the formation of human capital, and could have thus contributed to the relationship between industrialization and human capital formation. We thus account for population density in each French department in 1801 and 1821, as shown in Panels A and B of Figure C.2. Moreover, the early level of development, as measured by the degree of urbanization (i.e., population of urban centers with more than 10,000 inhabitants) in each French department in 1700 as shown in Panel C of Figure A.3 (Lepetit, 1994), may have persisted independently of the process of industrialization.

Reassuringly, as reported in Tables C.9 and C.10 in the Appendix, neither urbanization in 1700 nor population density in each French department in 1801 and 1821 have a qualitative impact

on the estimated effects and the statistical significance of industrialization on human capital.[21] Furthermore, in Table C.11, we recompute our main explanatory variable so that it is defined as the number of steam engines per inhabitant in each department in 1841. The regression results show that this other measure of industrialization has a systematically positive and significant effect on human capital accumulation.

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[21]The Tarn-et-Garonne department was established in 1812 from parts of Aveyron, Gers, Haute-Garonne, Lot and Lot-et-Garonne. Therefore, we lose one observation when population density in 1801 is included in the analysis.

Table C.9. *Industrialization & human capital formation, accounting for population density in the 19th c.*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV
	Share of Pupils Out of Population 5-15, 1840			Share of Literate Conscripts born between 1839 and 1848			Teachers 1840		
Number of Steam Engines	0.304*** [0.0818]	0.304*** [0.0822]	0.303*** [0.0823]	0.116*** [0.0346]	0.112*** [0.0343]	0.113*** [0.0345]	0.320*** [0.0873]	0.299*** [0.0859]	0.303*** [0.0862]
Population Density, 1801		0.0333 [0.197]			0.0410 [0.0804]			0.255*** [0.0987]	
Population Density, 1821			0.0147 [0.182]			0.0307 [0.0759]			0.226** [0.0995]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.491	0.74	0.74	0.74	742	742	742
Observations	85	84	85	85	84	85	85	84	85
	First stage: the instrumented variable is Number of Steam Engines								
Distance to Fresnes	-0.702*** [0.243]	-0.696*** [0.243]	-0.696*** [0.242]	-0.702*** [0.243]	-0.696*** [0.243]	-0.696*** [0.242]	-0.702*** [0.243]	-0.696*** [0.243]	-0.696*** [0.242]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.308*** [0.339]	-1.290*** [0.334]	-1.309*** [0.329]	-1.308*** [0.339]	-1.290*** [0.334]	-1.309*** [0.329]	-1.308*** [0.339]	-1.290*** [0.334]
F-stat	16.661	16.060	15.978	16.661	16.060	15.978	16.661	16.060	15.978
Prob J-Stat	0.507	0.526	0.507	0.530	0.503	0.524	0.320	0.239	0.292

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to the inclusion of the shares of the department's territory covered by the road and water networks in 1837. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.10. *Industrialization and human capital formation, accounting for urbanization in 1700*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304*** [0.0818]	0.332*** [0.0945]	0.116*** [0.0346]	0.125*** [0.0390]	0.282*** [0.0517]	0.258*** [0.0575]
Urban Population 1700		-0.0377 [0.0323]		-0.0122 [0.0148]		0.0314 [0.0263]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702*** [0.243]	-0.608** [0.238]	-0.702*** [0.243]	-0.608** [0.238]	-0.702*** [0.243]	-0.608** [0.238]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.170*** [0.345]	-1.309*** [0.329]	-1.170*** [0.345]	-1.309*** [0.329]	-1.170*** [0.345]
F-stat	16.661	10.918	16.661	10.918	16.661	10.918
Prob J-Stat	0.507	0.492	0.530	0.519	0.416	0.439

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department to Lepetit (1994)'s measure of urbanization in 1700. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.11. *Industrialization per inhabitant in 1841 and human capital formation*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304*** [0.0818]		0.116*** [0.0346]		0.320*** [0.0873]	
Number of Steam Engines per 10,000 Inhabitants, 1841		0.987*** [0.310]		0.376*** [0.130]		1.041*** [0.326]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702*** [0.243]	-0.237** [0.102]	-0.702*** [0.243]	-0.237** [0.102]	-0.702*** [0.243]	-0.237** [0.102]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-0.380*** [0.100]	-1.309*** [0.329]	-0.380*** [0.100]	-1.309*** [0.329]	-0.380*** [0.100]
F-stat	16.661	13.481	16.661	13.481	16.661	13.481
Prob J-Stat	0.507	0.675	0.530	0.682	0.320	0.565

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 as well as to the number of steam engines in 1839-1847 per inhabitant in 1841 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 in each department. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

C.5. Past Level of Fertility

Human capital formation and the number of steam engines across France could have been affected by differential fertility patterns across French departments (reflecting cultural characteristics as well as economic incentives). In particular, conditional on pre-industrial levels of economic and human capital development, departments in which fertility was higher prior to the 1839-1847 industrial survey may have had characteristics that enhanced fertility and lowered the level of investment in human capital (Galor, 2011). However, we find in Table C.12 that, although the level of fertility in 1806 has the predicted negative effect on the various measures of human capital formation in the

Table C.12.   *Industrialization and human capital formation, accounting for fertility in 1806*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304***	0.272***	0.116***	0.100***	0.320***	0.287***
	[0.0818]	[0.0782]	[0.0346]	[0.0344]	[0.0873]	[0.0824]
Fertility, 1806		-1.424***		-0.696***		-1.480***
		[0.499]		[0.205]		[0.445]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702***	-0.676***	-0.702***	-0.676***	-0.702***	-0.676***
	[0.243]	[0.235]	[0.243]	[0.235]	[0.243]	[0.235]
Net Increase in Wheat Prices in 1834-1838	-1.309***	-1.293***	-1.309***	-1.293***	-1.309***	-1.293***
(baseline 1819-1833)	[0.329]	[0.338]	[0.329]	[0.338]	[0.329]	[0.338]
F-stat	16.661	15.496	16.661	15.496	16.661	15.496
Prob J-Stat	0.507	0.596	0.530	0.632	0.320	0.384

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the inclusion of fertility in 1806 in each department. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

post-1840 period, it has no qualitative impact on the estimated effect of industrialization on human capital formation.[22]

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[22]1806 is the earliest year for which the level of fertility is available across French departments (Bonneuil, 1997). Accounting for fertility in subsequent years, including the ones contemporaneous to the survey, does not affect the results.

Table C.13. *The effect of industrialization on wages, 1839-1847*

	(1) OLS Average Male Wage 1839-1847	(2) OLS Average Female Wage 1839-1847	(3) OLS Average Child Wage 1839-1847
Number of Steam Engines	0.0615*** [0.0132]	0.0645*** [0.0157]	0.0526** [0.0214]
Adjusted R2	0.349	0.235	0.163
Observations	85	85	85
Geographic Characteristics	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes

Note: This table establishes the relationship of the OLS regressions where we relate the number of steam engines in 1839-1847 to the average wage of male, female and child industrial workers in 1839-1847 in each department. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

C.6 Investments in Education as a Consumption Good

The documented rise in human capital formation in the first phase of industrialization is not necessarily indicative of technology-skill complementarity. The positive effect of industrialization on income may have generated a demand for human capital as a consumption good rather than as an investment good. Indeed, as shown in Table C.13, the intensity of industrialization was associated with higher average wages for men and women, as well as children (below age 16) in 1839-1847.

Nevertheless, as established in Table C.14, the effect of industrialization on the various measures of human capital remains nearly intact, once one accounts for average male, female and child wages. In particular, the rise in parental income is almost always not associated with human capital formation (the average male wage in 1839-47 is never significant while the average female wage in 1839-47 is only significant in one regression) whereas the number of steam engines retains its positive impact on education. Moreover, the wages of children are unrelated to human capital formation,

Table C.14.   *Industrialization and human capital formation, accounting for wages in 1839-1847*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304*** [0.0818]	0.220* [0.124]	0.116*** [0.0346]	0.0628 [0.0441]	0.320*** [0.0873]	0.284** [0.130]
Average Male Wage, 1839-1847		-0.674 [0.619]		-0.190 [0.266]		-0.582 [0.519]
Average Female Wage, 1839-1847		0.474 [0.472]		0.403** [0.186]		0.452 [0.419]
Average Child Wage, 1839-1847		0.569 [0.386]		0.0624 [0.163]		0.243 [0.368]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
Observations	85	85	85	85	85	85
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702*** [0.243]	-0.650** [0.273]	-0.702*** [0.243]	-0.650** [0.273]	-0.702*** [0.243]	-0.650** [0.273]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.054*** [0.365]	-1.309*** [0.329]	-1.054*** [0.365]	-1.309*** [0.329]	-1.054*** [0.365]
F-stat	16.661	7.727	16.661	7.727	16.661	7.727
Prob J-Stat	0.507	0.297	0.530	0.164	0.320	0.223

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the inclusion of the wages of male, female and child industrial workers in 1839-1847. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

perhaps reflecting the compliance with the first limitation on child labor imposed by the 22 March 1841 law.

C.7. Early Literacy Rates and the Upper Tail of the Human Capital Distribution in the 18th century

Early literacy rates, as captured by the share of grooms who could sign their marriage license over the 1686-1690, 1786-1790 and 1816-1820 periods as mapped in Figure A.6 (Furet and Ozouf, 1977), may have affected the adoption of the steam engine while contributing to human capital accumulation independently of the process of industrialization.[23] Reassuringly, Table C.15 shows that the positive and significant effect of industrialization on human formation in the 19th century is not affected by these measures of early literacy.

Besides, the number of steam engines and human capital formation in the 19th century might have been affected by the upper tail of the human capital distribution in the previous centuries that we capture by three measures measures. We use a dummy for the presence of universities in 1700 (Frijhoff, 1996) and the distance from the main town (chef-lieu) of the department/arrondissement to the closest university in 1700. We also use the number of subscribers to the Quarto edition of the *Encyclopédie* (see Darnton (1973) and also Squicciarini and Voigtländer (2015)). As established above in Table C.1, these variables have no effect on the impact of the distance from Fresnes-sur-Escaut on the intensive use of the steam engine. Moreover, as reported in Tables C.16 and C.17, they do not have any qualitative impact on the estimated effect of steam engines on human capital formation.

Finally, a possible concern for the relevance of our results pertains to Article 9 of the 28 June 1833 Loi sur l'instruction primaire (i.e., often referred to as "Loi Guizot"after the name of the then Education minister François Guizot) stated that each commune must fund, on its own or jointly with other communes, an "elementary"primary school (Ecole Primaire Elémentaire), regardless of

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[23]Some observations are missing for these variables as we discuss in the historical section of the Appendix.

population size. The law also compelled communes with more than 500 inhabitants to have a school building in their jurisdiction (Montalbo, 2021). In other words, all communes with more than 500 inhabitants had a school building but some communes below this threshold also had a school building and were, in any case, required to fund primary schooling. Still, to ensure that our main results are robust to accounting for the consequences of the 28 June 1833 Loi sur l'instruction primaire, we rely on the data collected by Montalbo (2021) from the 1833 national survey on primary schooling. Specifically, we use the following department-level variables: the number of communes with school, the total number of schools and the total number of schools per inhabitant. Table C.18 shows that these variables are, as could be expected, positively and significantly correlated with our main measures of education, but that accounting for them does not modify the positive and significant impact of the number of steam engines in our regressions.

Table C.15. *Industrialization & human capital formation, accounting for grooms who could sign their marriage license in 1686-1690, 1786-1790 & 1816-1820*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV	(10) IV	(11) IV	(12) IV
	Share of Pupils Out of Population 5-15, 1840				Share of Literate Conscripts born between 1839 and 1848				Teachers 1840			
Number of Steam Engines	0.304*** [0.0818]	0.303*** [0.0756]	0.218*** [0.0688]	0.221*** [0.0579]	0.116*** [0.0346]	0.106*** [0.0307]	0.0763*** [0.0291]	0.0730*** [0.0251]	0.320*** [0.0873]	0.351*** [0.0902]	0.289*** [0.0823]	0.272*** [0.0853]
Grooms who Signed their Marriage License, 1686-1690		1.655*** [0.365]				0.822*** [0.148]				0.921*** [0.348]		
Grooms who Signed their Marriage License, 1786-1790			1.322*** [0.316]				0.554*** [0.149]				0.592* [0.312]	
Grooms who Signed their Marriage License, 1816-1820				1.862*** [0.249]				0.829*** [0.114]				1.128*** [0.273]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.74	0.74	0.74	0.74	742	742	742	742
Observations	85	76	79	78	85	76	79	78	85	76	79	78
	First stage: the instrumented variable is Number of Steam Engines											
Distance to Fresnes	-0.702*** [0.243]	-0.691*** [0.256]	-0.691** [0.261]	-0.595** [0.253]	-0.702*** [0.243]	-0.691*** [0.256]	-0.691** [0.261]	-0.595** [0.253]	-0.702*** [0.243]	-0.691*** [0.256]	-0.691** [0.261]	-0.595** [0.253]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.229*** [0.340]	-1.279*** [0.343]	-1.265*** [0.338]	-1.309*** [0.329]	-1.229*** [0.340]	-1.279*** [0.343]	-1.265*** [0.338]	-1.309*** [0.329]	-1.229*** [0.340]	-1.279*** [0.343]	-1.265*** [0.338]
F-stat	16.661	13.906	13.209	13.554	16.661	13.906	13.209	13.554	16.661	13.906	13.209	13.554
Prob J-Stat	0.507	0.687	0.588	0.684	0.530	0.529	0.525	0.723	0.320	0.643	0.391	0.523

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the inclusion of the shares of grooms who could sign their wedding licenses in 1686-1690, 1786-1790 & 1816-1820. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.16. *Industrialization and human capital formation, accounting for the upper tail of the human capital distribution in the 18th century*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
	Share of Pupils Out of Population 5-15, 1840		Share of Literate Conscripts born between 1839 and 1848		Teachers 1840	
Number of Steam Engines	0.304*** [0.0818]	0.294*** [0.0890]	0.116*** [0.0346]	0.101*** [0.0340]	0.320*** [0.0873]	0.286*** [0.0923]
Encyclopedie subscribers		0.000150 [0.000266]		0.000196 [0.000121]		0.000466** [0.000223]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85	85	85	85	85	85
Mean Value of Dependent Variable	0.491	0.491	0.74	0.74	742	742
	First stage: the instrumented variable is Number of Steam Engines					
Distance to Fresnes	-0.702*** [0.243]	-0.685*** [0.244]	-0.702*** [0.243]	-0.685*** [0.244]	-0.702*** [0.243]	-0.685*** [0.244]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.210*** [0.351]	-1.309*** [0.329]	-1.210*** [0.351]	-1.309*** [0.329]	-1.210*** [0.351]
F-stat	16.661	13.258	16.661	13.258	16.661	13.258
Prob J-Stat	0.507	0.468	0.530	0.412	0.320	0.227

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the inclusion of the number of Encyclopédie subscribers. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.17. *Industrialization and human capital formation, accounting for the presence of universities in 1700 and for the distance from the main town (chef-lieu) of the department/arrondissement to the closest university in 1700.*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9)0 IV 0
	Share of Pupils Out of Population 5-15, 1840			Share of Literate Conscripts born between 1839 and 1848			Teachers 1840		
Number of Steam Engines	0.304*** [0.0818]	0.336*** [0.0881]	0.317*** [0.0829]	0.116*** [0.0346]	0.128*** [0.0374]	0.118*** [0.0352]	0.320*** [0.0873]	0.348*** [0.0927]	0.325*** [0.0924]
University 1700		-0.237* [0.133]			-0.0936 [0.0573]			-0.198 [0.129]	
Distance to University 1700			0.00111 [0.000754]			0.000243 [0.000377]			0.000468 [0.000736]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Value of Dependent Variable	0.491	0.491	0.491	0.74	0.74	0.74	742	742	742
Observations	85	85	85	85	85	85	85	85	85
First stage: the instrumented variable is Number of Steam Engines									
Distance to Fresnes	-0.702*** [0.243]	-0.724*** [0.203]	-0.662*** [0.234]	-0.702*** [0.243]	-0.724*** [0.203]	-0.662*** [0.234]	-0.702*** [0.243]	-0.724*** [0.203]	-0.662*** [0.234]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.092*** [0.333]	-1.287*** [0.327]	-1.309*** [0.329]	-1.092*** [0.333]	-1.287*** [0.327]	-1.309*** [0.329]	-1.092*** [0.333]	-1.287*** [0.327]
F-stat	16.661	15.948	16.896	16.661	15.948	16.896	16.661	15.948	16.896
Prob J-Stat	0.507	0.721	0.450	0.530	0.726	0.499	0.320	0.507	0.292

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the presence of universities in 1700 as well as to the distance between the main town (chef-lieu) of the department/arrondissement and the closest university in 1700. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table C.18. *Industrialization & primary schooling in 1833*

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV	(8) IV	(9) IV	(10) IV	(11) IV	(12) IV
	Share of Pupils Out of Population 5-15, 1840				Share of Literate Conscripts born between 1839 and 1848				Teachers 1840			
Number of Steam Engines	0.304*** [0.0818]	0.233*** [0.0737]	0.221*** [0.0787]	0.204*** [0.0675]	0.116*** [0.0346]	0.0797*** [0.0304]	0.0711** [0.0311]	0.0661*** [0.0252]	0.320*** [0.0873]	0.241*** [0.0835]	0.215** [0.0923]	0.269*** [0.0843]
Communes with school		0.323*** [0.0742]				0.167*** [0.0373]				0.363*** [0.0912]		
Total number of schools			0.338*** [0.0863]				0.189*** [0.0400]				0.439*** [0.102]	
Total number of schools per inhabitant				0.535*** [0.0675]				0.265*** [0.0339]				0.284*** [0.0824]
Geographic Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institutional Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yess
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.74	0.74	0.74	0.74 742	742	742	742	
Observations	85	85	85	85	85	85	85	85	85	85	85	85
First stage: the instrumented variable is Number of Steam Engines												
Distance to Fresnes	-0.702*** [0.243]	-0.588** [0.264]	-0.434 [0.265]	-0.784*** [0.267]	-0.702*** [0.243]	-0.588** [0.264]	-0.434 [0.265]	-0.784*** [0.267]	-0.702*** [0.243]	-0.588** [0.264]	-0.434 [0.265]	-0.784*** [0.267]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309*** [0.329]	-1.328*** [0.328]	-1.349*** [0.323]	-1.268*** [0.330]	-1.309*** [0.329]	-1.328*** [0.328]	-1.349*** [0.323]	-1.268*** [0.330]	-1.309*** [0.329]	-1.328*** [0.328]	-1.349*** [0.323]	-1.268*** [0.330]
F-stat (1st stage)	16.661	15.045	14.841	15.748	16.661	15.045	14.841	15.748	16.661	15.045	14.841	15.748
Prob J-Stat	0.507	0.741	0.567	0.076	0.530	0.543	0.294	0.017	0.320	0.538	0.127	0.581

Note: This table establishes the robustness of the IV regressions where we relate the number of steam engines in 1839-1847 to the share of pupils in 1840, the share of literate conscripts born between 1839 and 1848 and the number of teachers in 1840 to the inclusion of the number of communes with primary schools, the total number of schools and the total number of schools per inhabitant in 1833. The relationship is robust to accounting for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Appendix D. Tables – Full Set of Controls for the Main Results

Table D.1. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
	Share of Primary School Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122***	0.137***	0.131***	0.304***	0.000173***	0.0002**	0.0002**	-0.0005
	[0.0369]	[0.0436]	[0.0468]	[0.0818]	[5.83e-05]	[8.21e-05]	[7.74e-05]	[0.0004]
Average Rainfall		0.558**	0.718***	0.899***		0.000366	-0.000531	-0.00115*
		[0.272]	[0.267]	[0.259]		[0.000553]	[0.000586]	[0.000685]
Average Temperature		-2.106***	-1.943***	-1.807***		-0.000231	-0.00150**	-0.00121*
		[0.425]	[0.407]	[0.446]		[0.000645]	[0.000628]	[0.000636]
Latitude		-0.369	0.155	-0.654		2.75e-05	3.33e-05	8.34e-05**
		[1.122]	[2.786]	[2.529]		[3.63e-05]	[3.00e-05]	[4.13e-05]
Land Suitability		0.811***	0.584***	0.527***		-5.13e-05	0.000131	0.000103
		[0.243]	[0.191]	[0.176]		[0.000256]	[0.000236]	[0.000285]
Share of Carboniferous Area			-0.927**	-0.975***			-0.000619	-0.000185
			[0.366]	[0.331]			[0.000486]	[0.000641]
Distance to Paris			0.00751	0.0169			0.000139***	0.000103*
			[0.0800]	[0.0779]			[4.93e-05]	[5.63e-05]
Paris and Suburbs			0.0316	-0.0270			-0.000435*	-0.000427*
			[0.180]	[0.227]			[0.000248]	[0.000250]
Maritime Department			0.0154	-0.112				
			[0.0998]	[0.117]				
Border Department			0.0244	-0.0132				
			[0.108]	[0.135]				
Maritime Arrondissement							0.000582**	0.000839***
							[0.000222]	[0.000289]
Border Arrondissement							1.49e-05	0.000351
							[0.000306]	[0.000429]
Constant	-1.142***	1.666	-1.824	-0.738	0.00127***	-0.000831	0.00781*	0.0125**
	[0.117]	[5.811]	[11.49]	[10.83]	[9.67e-05]	[0.00394]	[0.00433]	[0.00509]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
Oster β		0.170	0.144			0.004	0.0003	
Adjusted R2	0.091	0.428	0.454		0.027	0.026	0.084	
Observations	85	85	85	85	355	355	355	355
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines							
Distance to Fresnes				-0.702***				-0.214*
				[0.243]				[0.122]
Net Increase in Wheat Prices in 1834-1838				-1.309***				-0.455***
(baseline 1819-1833)				[0.329]				[0.113]
F-stat				16.661				9.613
Prob J-Stat				0.507				0.255
	Reduced Form: the dependent variable is							
	Share of Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Distance to Fresnes				-0.276***				-6.26e-06
				[0.103]				[0.0001]
Net Increase in Wheat Prices in 1834-1838				-0.317**				0.0005**
(baseline 1819-1833)				[0.148]				[0.0002]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table D.2. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461**	0.0364	0.0401**	0.116***	0.0452***	0.0314***	0.139***
	[0.0223]	[0.0220]	[0.0200]	[0.0346]	[0.00677]	[0.00689]	[0.0167]
Male					0.000492	-0.00159	0.00369
					[0.0112]	[0.0111]	[0.0118]
Average Rainfall		0.0867	0.242**	0.321***			
		[0.130]	[0.121]	[0.119]			
Average Temperature		-0.810***	-0.540***	-0.480**			
		[0.211]	[0.175]	[0.190]			
Latitude		-0.237	0.234	-0.121			
		[0.613]	[1.410]	[1.229]			
Land Suitability		0.367***	0.232***	0.207***			
		[0.108]	[0.0803]	[0.0740]			
Share of Carboniferous Area			-0.475**	-0.496**			
			[0.220]	[0.198]			
Maritime Department			-0.0788*	-0.135**		-0.0538***	-0.140***
			[0.0472]	[0.0595]		[0.0192]	[0.0254]
Border Department			0.0441	0.0276		0.109***	0.0309
			[0.0530]	[0.0621]		[0.0215]	[0.0340]
Distance to Paris			0.00795	0.0121		-0.0267***	0.00188
			[0.0413]	[0.0391]		[0.00455]	[0.00699]
Paris and Suburbs			0.227***	0.201**		0.121***	0.0774**
			[0.0732]	[0.0910]		[0.0233]	[0.0317]
Constant	-0.448***	1.924	-1.607	-1.131	0.665***	0.786***	0.379***
	[0.0742]	[3.203]	[5.552]	[5.001]	[0.0329]	[0.0386]	[0.0647]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
Oster β		-0.025	0.037		0.047	0.022	
Adjusted R2	0.046	0.289	0.396		0.024	0.048	
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines						
Distance to Fresnes				-0.702***			-0.475***
				[0.243]			[0.0782]
Net Increase in Wheat Prices in 1834-1838				-1.309***			-1.165***
(baseline 1819-1833)				[0.329]			[0.131]
F-stat				16.661			118.814
Prob J-Stat				0.530			0.030
	Reduced Form: the dependent variable is						
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Distance to Fresnes				-0.107**			-0.0334***
				[0.0461]			[0.0127]
Net Increase in Wheat Prices in 1834-1838				-0.119*			-0.219***
(baseline 1819-1833)				[0.0621]			[0.0242]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table D.3. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period.*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.190***	0.320***	0.129***	0.125***	0.137***	0.266***	0.270**	0.148*	0.191**	0.424***	-0.921***	-0.708***	-0.654***	-0.896***
	[0.0329]	[0.0357]	[0.0387]	[0.0873]	[0.0255]	[0.0316]	[0.0316]	[0.0631]	[0.102]	[0.0855]	[0.0796]	[0.122]	[0.115]	[0.180]	[0.193]	[0.319]
Average Rainfall		1.019***	1.108***	1.244***		-0.404*	-0.486*	-0.350		1.041	0.426	0.671		2.474*	2.563	2.309
		[0.265]	[0.283]	[0.275]		[0.233]	[0.276]	[0.277]		[0.712]	[0.627]	[0.663]		[1.395]	[1.660]	[1.551]
Average Temperature		-0.939***	-1.146***	-1.044***		0.554**	0.602**	0.704***		3.257***	2.401***	2.583***		-2.800	-0.256	-0.445
		[0.269]	[0.396]	[0.400]		[0.221]	[0.258]	[0.253]		[0.897]	[0.840]	[0.802]		[1.820]	[1.926]	[1.729]
Latitude		1.007	3.729	3.119		0.0929	4.478**	3.873**		7.992**	17.26***	16.17***		-9.345*	-17.23	-16.10
		[1.141]	[2.705]	[2.493]		[1.026]	[1.832]	[1.838]		[3.135]	[4.057]	[3.945]		[5.421]	[12.89]	[12.68]
Land Suitability		0.459***	0.378**	0.335**		-0.0285	0.0584	0.0153		0.215	0.456	0.378		0.367	-0.337	-0.256
		[0.157]	[0.159]	[0.149]		[0.118]	[0.125]	[0.120]		[0.428]	[0.332]	[0.316]		[1.019]	[1.013]	[0.952]
Share of Carboniferous Area			-0.635**	-0.672**			0.225	0.189			0.198	0.133			-0.733	-0.666
			[0.318]	[0.282]			[0.295]	[0.273]			[0.670]	[0.600]			[1.455]	[1.354]
Maritime Department			0.0926	-0.00365			-0.221**	-0.317***			-0.347**	-0.519***			-0.462	-0.283
			[0.127]	[0.160]			[0.0881]	[0.107]			[0.169]	[0.181]			[0.560]	[0.535]
Border Department			-0.0604	-0.0887			-0.127	-0.155			-0.884***	-0.934***			1.013*	1.065**
			[0.120]	[0.120]			[0.0991]	[0.103]			[0.276]	[0.252]			[0.569]	[0.531]
Distance to Paris			0.0928	0.0999			0.142**	0.149**			0.302***	0.315***			-0.342	-0.355
			[0.0834]	[0.0829]			[0.0617]	[0.0623]			[0.107]	[0.107]			[0.382]	[0.365]
Paris and Suburbs			0.578***	0.534***			0.466*	0.422*			-1.350	-1.430			-1.824**	-1.741**
			[0.195]	[0.146]			[0.265]	[0.238]			[1.399]	[1.386]			[0.820]	[0.875]
Constant	6.080***	-2.465	-13.30	-12.48	6.086***	7.146	-9.722	-8.909	3.432***	-41.59**	-71.83***	-70.36***	5.103***	30.46	55.03	53.51
	[0.104]	[5.664]	[10.81]	[10.30]	[0.0610]	[4.964]	[7.013]	[7.192]	[0.298]	[15.99]	[17.93]	[17.15]	[0.370]	[26.54]	[51.11]	[49.44]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
Oster β		0.397	0.242			-1.297	0.168			-0.538	0.086			0.576	0.095	
Adjusted R2	0.187	0.381	0.431		0.232	0.305	0.370		0.113	0.276	0.422		0.292	0.354	0.363	
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

First stage: the instrumented variable is Number of Steam Engines

	(4)	(8)	(12)	(16)
Distance to Fresnes	-0.702***	-0.702***	-0.702***	-0.702***
	[0.243]	[0.243]	[0.243]	[0.243]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.309***	-1.309***	-1.309***	-1.309***
	[0.329]	[0.329]	[0.329]	[0.329]
F-stat	16.661	16.661	16.661	16.661
Prob J-Stat	0.320	0.463	0.822	0.001

Reduced Form: the dependent variable is

	Teachers 1840	Commune Spending on Primary Schooling per Inhabitant, 1855-1863	Department Spending on Primary Schooling per Inhabitant, 1855-1863	Central State Spending on Primary Schooling per Inhabitant, 1855-1863
Distance to Fresnes	-0.296***	-0.139*	-0.139*	-0.139*
	[0.0823]	[0.0760]	[0.0760]	[0.0760]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-0.328**	-0.409***	-0.409***	-0.409***
	[0.163]	[0.121]	[0.121]	[0.121]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Appendix E. Main Results Accounting for Distances to Sea and Border

Table E.1. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
	Share of Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122***	0.137***	0.117**	0.257***	0.000173***	0.000213**	0.000208**	-0.000603
	[0.0369]	[0.0436]	[0.0463]	[0.0787]	[5.83e-05]	[8.21e-05]	[7.99e-05]	[0.000517]
Average Rainfall		0.558**	0.728**	0.832***		0.000366	-0.000377	-0.000915
		[0.272]	[0.275]	[0.252]		[0.000553]	[0.000597]	[0.000670]
Average Temperature		-2.106***	-1.743***	-1.725***		-0.000231	-0.00132**	-0.000774
		[0.425]	[0.344]	[0.350]		[0.000645]	[0.000648]	[0.000741]
Latitude		-0.369	-2.180	-2.807		2.75e-05	3.28e-05	0.000113*
		[1.122]	[2.444]	[2.225]		[3.63e-05]	[3.53e-05]	[5.90e-05]
Land Suitability		0.811***	0.498***	0.484***		-5.13e-05	4.22e-05	-0.000132
		[0.243]	[0.176]	[0.162]		[0.000256]	[0.000238]	[0.000298]
Share of Carboniferous Area			-0.798**	-0.832***			-0.000755	-0.000129
			[0.357]	[0.310]			[0.000485]	[0.000655]
Distance to Border			-0.127***	-0.0902**			1.18e-05	-8.61e-05
			[0.0433]	[0.0437]			[7.58e-05]	[0.000114]
Distance to Sea			-0.0286	-0.00199			-7.40e-05	-0.000210**
			[0.0322]	[0.0312]			[5.84e-05]	[9.21e-05]
Distance to Paris			-0.0758	-0.0605			0.000136**	5.79e-05
			[0.0715]	[0.0682]			[5.54e-05]	[7.12e-05]
Paris and Suburbs			-0.0337	-0.0790			-0.000466*	-0.000479*
			[0.163]	[0.196]			[0.000257]	[0.000267]
Constant	-1.142***	1.666	7.699	8.613	0.00127***	-0.000831	0.00667	0.0116**
	[0.117]	[5.811]	[10.21]	[9.562]	[9.67e-05]	[0.00394]	[0.00433]	[0.00499]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
Oster β		0.184	0.112			0.003	0.0004	
Adjusted R2	0.091	0.428	0.489		0.027	0.026	0.064	
Observations	85	85	85	85	355	355	355	355
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines							
Distance to Fresnes				-0.993***				-0.170
				[0.286]				[0.145]
Net Increase in Wheat Prices in 1834-1838				-1.105***				-0.388***
(baseline 1819-1833)				[0.334]				[0.124]
F-stat				18.709				5.628
Prob J-Stat				0.565				0.107
	Reduced Form: the dependent variable is							
	Share of Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Distance to Fresnes				-0.186				-9.69e-05
				[0.121]				[0.000100]
Net Increase in Wheat Prices in 1834-1838				-0.358**				0.000593**
(baseline 1819-1833)				[0.148]				[0.000252]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table E.2. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461** [0.0223]	0.0364 [0.0220]	0.0311 [0.0194]	0.0857** [0.0343]	0.0452*** [0.00677]	0.0217*** [0.00690]	0.0951*** [0.0163]
Male					0.000492 [0.0112]	0.000102 [0.0111]	0.00171 [0.0114]
Average Rainfall		0.0867 [0.130]	0.209 [0.135]	0.250* [0.128]			
Average Temperature		-0.810*** [0.211]	-0.543*** [0.147]	-0.536*** [0.146]			
Latitude		-0.237 [0.613]	-0.939 [1.292]	-1.186 [1.114]			
Land Suitability		0.367*** [0.108]	0.212*** [0.0715]	0.207*** [0.0671]			
Share of Carboniferous Area			-0.413* [0.210]	-0.426** [0.186]			
Distance to Sea			0.00755 [0.0184]	0.0180 [0.0179]		0.0103* [0.00527]	0.0259*** [0.00617]
Distance to Border			-0.0533** [0.0226]	-0.0389* [0.0222]		-0.0513*** [0.00623]	-0.0222** [0.00986]
Distance to Paris			-0.0273 [0.0398]	-0.0213 [0.0370]		-0.0252*** [0.00447]	-0.00295 [0.00622]
Paris and Suburbs			0.197*** [0.0668]	0.179** [0.0755]		0.150*** [0.0247]	0.114*** [0.0294]
Constant	-0.448*** [0.0742]	1.924 [3.203]	3.492 [5.040]	3.851 [4.441]	0.665*** [0.0329]	1.030*** [0.0587]	0.485*** [0.106]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
Oster β		-0.025	0.037		0.047	0.022	
Adjusted R2	0.046	0.289	0.427		0.024	0.056	
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes
	First stage: the instrumented variable is Number of Steam Engines						
Distance to Fresnes				-0.993*** [0.286]			-0.716*** [0.105]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-1.105*** [0.334]			-0.977*** [0.136]
F-stat				18.709			115.481
Prob J-Stat				0.531			0.000
	Reduced Form: the dependent variable is						
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Distance to Fresnes				-0.0538 [0.0551]			0.0204 [0.0161]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)				-0.129** [0.0626]			-0.231*** [0.0235]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table E.3. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.183***	0.312***	0.129***	0.125***	0.125***	0.250***	0.270**	0.148*	0.158	0.432**	-0.921***	-0.708***	-0.729***	-1.097***
	[0.0329]	[0.0357]	[0.0382]	[0.0846]	[0.0255]	[0.0316]	[0.0323]	[0.0782]	[0.102]	[0.0855]	[0.0950]	[0.171]	[0.115]	[0.180]	[0.179]	[0.316]
Average Rainfall		1.019***	1.163***	1.260***		-0.404*	-0.559*	-0.465		1.041	0.357	0.563		2.474*	2.292	2.016
		[0.265]	[0.308]	[0.292]		[0.233]	[0.312]	[0.309]		[0.712]	[0.672]	[0.676]		[1.395]	[1.654]	[1.532]
Average Temperature		-0.939***	-0.918***	-0.902***		0.554**	0.558*	0.574**		3.257***	3.006***	3.040***		-2.800	-0.381	-0.427
		[0.269]	[0.328]	[0.334]		[0.221]	[0.283]	[0.276]		[0.897]	[0.939]	[0.928]		[1.820]	[1.561]	[1.463]
Latitude		1.007	2.132	1.552		0.0929	2.709*	2.148		7.992**	9.984**	8.750**		-9.345*	-25.53**	-23.87**
		[1.141]	[2.419]	[2.194]		[1.026]	[1.586]	[1.529]		[3.135]	[4.262]	[4.103]		[5.421]	[12.60]	[12.34]
Land Suitability		0.459***	0.305*	0.292*		-0.0285	0.0749	0.0625		0.215	0.369	0.341		0.367	-0.570	-0.533
		[0.157]	[0.159]	[0.154]		[0.118]	[0.151]	[0.149]		[0.428]	[0.389]	[0.376]		[1.019]	[0.889]	[0.848]
Share of Carboniferous Area			-0.546	-0.576**			0.343	0.313			0.728	0.663			-0.364	-0.276
			[0.329]	[0.292]			[0.320]	[0.298]			[0.787]	[0.719]			[1.391]	[1.301]
Distance to Border			-0.0757	-0.0418			0.0142	0.0469			0.0333	0.105			-0.658***	-0.754***
			[0.0520]	[0.0575]			[0.0507]	[0.0652]			[0.128]	[0.149]			[0.238]	[0.247]
Distance to Sea			-0.0434	-0.0188			0.0340	0.0578*			0.00155	0.0538			0.0445	-0.0257
			[0.0377]	[0.0423]			[0.0294]	[0.0310]			[0.0755]	[0.0836]			[0.173]	[0.176]
Distance to Paris			0.0290	0.0431			0.0928	0.106*			0.0520	0.0820			-0.586	-0.626*
			[0.0795]	[0.0783]			[0.0568]	[0.0562]			[0.122]	[0.115]			[0.391]	[0.372]
Paris and Suburbs			0.533***	0.492***			0.422*	0.382*			-1.560	-1.649			-2.037**	-1.917*
			[0.200]	[0.142]			[0.252]	[0.216]			[1.435]	[1.463]			[0.869]	[0.990]
Constant	6.080***	-2.465	-7.265	-6.419	6.086***	7.146	-2.442	-1.625	3.432***	-41.59**	-44.38**	-42.58**	5.103***	30.46	93.25*	90.84*
	[0.104]	[5.664]	[9.637]	[8.931]	[0.0610]	[4.964]	[6.332]	[5.977]	[0.298]	[15.99]	[19.62]	[18.75]	[0.370]	[26.54]	[50.57]	[49.17]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
Oster β		0.411	0.221			-0.680	0.105			-0.245	0.018			0.977	-0.065	
Adjusted R2	0.187	0.381	0.440		0.232	0.305	0.330		0.113	0.276	0.332		0.292	0.354	0.401	
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

First stage: the instrumented variable is Number of Steam Engines

	(4)	(8)	(12)	(16)
Distance to Fresnes	-0.993***	-0.993***	-0.993***	-0.993***
	[0.286]	[0.286]	[0.286]	[0.286]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-1.105***	-1.105***	-1.105***	-1.105***
	[0.334]	[0.334]	[0.334]	[0.334]
F-stat	18.709	18.709	18.709	18.709
Prob J-Stat	0.949	0.258	0.169	0.006

Reduced Form: the dependent variable is

	Teachers 1840	Commune Spending on Primary Schooling per Inhabitant, 1855-1863	Department Spending on Primary Schooling per Inhabitant, 1855-1863	Central State Spending on Primary Schooling per Inhabitant, 1855-1863
Distance to Fresnes	-0.316***	-0.127	-0.127	-0.127
	[0.0931]	[0.132]	[0.132]	[0.132]
Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833)	-0.339**	-0.408***	-0.408***	-0.408***
	[0.166]	[0.111]	[0.111]	[0.111]

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.1. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842, accounting for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
		Share of Pupils Out of Population 5-15, 1840			Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122** [0.0498]	0.137** [0.0534]	0.131** [0.0513]	0.304*** [0.0901]	0.000173*** [6.04e-05]	0.000213*** [7.72e-05]	0.000192** [7.73e-05]	-0.000528 [0.000467]
Average Rainfall		0.558* [0.321]	0.718** [0.320]	0.899*** [0.314]		0.000366 [0.000609]	-0.000531 [0.000518]	-0.00115* [0.000661]
Average Temperature		-2.106*** [0.531]	-1.943*** [0.447]	-1.807*** [0.497]		-0.000231 [0.000763]	-0.00150** [0.000605]	-0.00121** [0.000599]
Latitude		-0.369 [1.371]	0.155 [3.590]	-0.654 [3.187]		2.75e-05 [3.18e-05]	3.33e-05 [2.37e-05]	8.34e-05** [4.05e-05]
Land Suitability		0.811*** [0.275]	0.584*** [0.204]	0.527*** [0.201]		-5.13e-05 [0.000270]	0.000131 [0.000211]	0.000103 [0.000282]
Share of Carboniferous Area			-0.927** [0.391]	-0.975*** [0.377]			-0.000619 [0.000555]	-0.000185 [0.000722]
Distance to Paris			0.00751 [0.0976]	0.0169 [0.0989]			0.000139*** [3.88e-05]	0.000103** [4.80e-05]
Paris and Suburbs			0.0316 [0.202]	-0.0270 [0.207]			-0.000435*** [0.000167]	-0.000427 [0.000306]
Maritime Department			0.0154 [0.114]	-0.112 [0.130]				
Border Department			0.0244 [0.106]	-0.0132 [0.134]				
Maritime Arrondissement							0.000582*** [0.000195]	0.000839*** [0.000308]
Border Arrondissement							1.49e-05 [0.000302]	0.000351 [0.000390]
Constant	-1.142*** [0.172]	1.666 [7.008]	-1.824 [14.42]	-0.738 [13.41]	0.00127*** [9.77e-05]	-0.000831 [0.00475]	0.00781** [0.00369]	0.0125*** [0.00459]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
R2	0.102	0.469	0.525		0.029	0.043	0.113	
Observations	85	85	85	85	355	355	355	355
F-stat				46.159				9.523
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842, accounting for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Appendix F. Main Results Accounting for Spatial Autocorrelation

Table F.2. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842, accounting for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
		Share of Pupils Out of Population 5-15, 1840			Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122**	0.137***	0.131***	0.304***	0.000173***	0.000213***	0.000192***	-0.000528
	[0.0497]	[0.0502]	[0.0340]	[0.0858]	[4.22e-05]	[4.95e-05]	[6.02e-05]	[0.000384]
Average Rainfall		0.558***	0.718***	0.899***		0.000366	-0.000531	-0.00115
		[0.214]	[0.255]	[0.256]		[0.000879]	[0.000760]	[0.000891]
Average Temperature		-2.106***	-1.943***	-1.807***		-0.000231	-0.00150***	-0.00121**
		[0.540]	[0.206]	[0.260]		[0.000630]	[0.000279]	[0.000557]
Latitude		-0.369	0.155	-0.654		2.75e-05	3.33e-05**	8.34e-05**
		[1.488]	[3.967]	[2.201]		[4.50e-05]	[1.67e-05]	[3.47e-05]
Land Suitability		0.811***	0.584***	0.527***		-5.13e-05	0.000131	0.000103
		[0.294]	[0.184]	[0.180]		[0.000374]	[0.000200]	[0.000304]
Share of Carboniferous Area			-0.927***	-0.975**			-0.000619	-0.000185
			[0.330]	[0.380]			[0.000469]	[0.000586]
Distance to Paris			0.00751	0.0169			0.000139***	0.000103**
			[0.110]	[0.0781]			[3.23e-05]	[4.35e-05]
Paris and Suburbs			0.0316	-0.0270			-0.000435***	-0.000427**
			[0.188]	[0.159]			[0.000124]	[0.000186]
Maritime Department			0.0154	-0.112				
			[0.114]	[0.173]				
Border Department			0.0244	-0.0132				
			[0.0729]	[0.109]				
Maritime Arrondissement							0.000582**	0.000839**
							[0.000228]	[0.000341]
Border Arrondissement							1.49e-05	0.000351
							[0.000352]	[0.000487]
Constant	-1.142***	1.666	-1.824	-0.738	0.00127***	-0.000831	0.00781	0.0125*
	[0.212]	[7.095]	[14.22]	[8.836]	[7.03e-05]	[0.00648]	[0.00561]	[0.00653]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
R2	0.102	0.469	0.525		0.029	0.043	0.113	
F-stat								39.783
Observations	85	85	85	85	355	355	355	355
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842, accounting for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.3. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
		Share of Pupils Out of Population 5-15, 1840			Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122**	0.137**	0.117**	0.257***	0.000173***	0.000213***	0.000208***	-0.000603
	[0.0498]	[0.0534]	[0.0499]	[0.0834]	[6.04e-05]	[7.72e-05]	[7.64e-05]	[0.000541]
Average Rainfall		0.558*	0.728**	0.832***		0.000366	-0.000377	-0.000915
		[0.321]	[0.336]	[0.316]		[0.000609]	[0.000542]	[0.000664]
Average Temperature		-2.106***	-1.743***	-1.725***		-0.000231	-0.00132**	-0.000774
		[0.531]	[0.331]	[0.360]		[0.000763]	[0.000633]	[0.000790]
Latitude		-0.369	-2.180	-2.807		2.75e-05	3.28e-05	0.000113*
		[1.371]	[2.836]	[2.548]		[3.18e-05]	[2.85e-05]	[6.15e-05]
Land Suitability		0.811***	0.498***	0.484***		-5.13e-05	4.22e-05	-0.000132
		[0.275]	[0.187]	[0.188]		[0.000270]	[0.000210]	[0.000323]
Share of Carboniferous Area			-0.798**	-0.832**			-0.000755	-0.000129
			[0.394]	[0.358]			[0.000536]	[0.000761]
Distance to Border			-0.127***	-0.0902*			1.18e-05	-8.61e-05
			[0.0471]	[0.0465]			[8.11e-05]	[0.000114]
Distance to Sea			-0.0286	-0.00199			-7.40e-05	-0.000210**
			[0.0296]	[0.0292]			[5.89e-05]	[0.000105]
Distance to Paris			-0.0758	-0.0605			0.000136***	5.79e-05
			[0.0794]	[0.0810]			[4.84e-05]	[7.30e-05]
Paris and Suburbs			-0.0337	-0.0790			-0.000466***	-0.000479
			[0.188]	[0.193]			[0.000166]	[0.000319]
Constant	-1.142***	1.666	7.699	8.613	0.00127***	-0.000831	0.00667*	0.0116**
	[0.172]	[7.008]	[11.40]	[10.94]	[9.77e-05]	[0.00475]	[0.00381]	[0.00474]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
R2	0.102	0.469	0.556		0.029	0.043	0.093	
Observations	85	85	85	85	355	355	355	355
F-stat				50.621				6.145
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.4. *The effect of industrialization on the share of primary school pupils in 1840 and on the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV
	Share of Pupils Out of Population 5-15, 1840				Share of Middle- and High-School Pupils Out of Population, 1842			
Number of Steam Engines	0.122**	0.137***	0.117***	0.257***	0.000173***	0.000213***	0.000208***	-0.000603
	[0.0497]	[0.0502]	[0.0294]	[0.0732]	[4.22e-05]	[4.95e-05]	[5.98e-05]	[0.000465]
Average Rainfall		0.558***	0.728***	0.832***		0.000366	-0.000377	-0.000915
		[0.214]	[0.226]	[0.198]		[0.000879]	[0.000784]	[0.000893]
Average Temperature		-2.106***	-1.743***	-1.725***		-0.000231	-0.00132***	-0.000774
		[0.540]	[0.187]	[0.0879]		[0.000630]	[0.000304]	[0.000735]
Latitude		-0.369	-2.180	-2.807		2.75e-05	3.28e-05	0.000113**
		[1.488]	[2.783]	[1.843]		[4.50e-05]	[2.62e-05]	[5.26e-05]
Land Suitability		0.811***	0.498***	0.484***		-5.13e-05	4.22e-05	-0.000132
		[0.294]	[0.184]	[0.184]		[0.000374]	[0.000221]	[0.000303]
Share of Carboniferous Area			-0.798***	-0.832***			-0.000755**	-0.000129
			[0.230]	[0.281]			[0.000379]	[0.000484]
Distance to Border			-0.127***	-0.0902**			1.18e-05	-8.61e-05
			[0.0411]	[0.0424]			[9.17e-05]	[0.000132]
Distance to Sea			-0.0286	-0.00199			-7.40e-05	-0.000210*
			[0.0177]	[0.0225]			[7.33e-05]	[0.000120]
Distance to Paris			-0.0758	-0.0605			0.000136***	5.79e-05
			[0.0898]	[0.0789]			[3.93e-05]	[5.81e-05]
Paris and Suburbs			-0.0337	-0.0790			-0.000466***	-0.000479***
			[0.152]	[0.140]			[0.000126]	[0.000176]
Constant	-1.142***	1.666	7.699	8.613	0.00127***	-0.000831	0.00667	0.0116*
	[0.212]	[7.095]	[9.661]	[7.015]	[7.03e-05]	[0.00648]	[0.00576]	[0.00666]
Mean Value of Dependent Variable	0.491	0.491	0.491	0.491	0.0015	0.0015	0.0015	0.0015
R2	0.102	0.469	0.556		0.029	0.043	0.093	
F-stat								21.068
Observations	85	85	85	85	355	355	355	355
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of primary school pupils in 1840 and to the share of middle and high-school pupils in the population in 1842, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.5. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461*	0.0364	0.0401*	0.116***	0.0452**	0.0314*	0.139***
	[0.0277]	[0.0275]	[0.0238]	[0.0392]	[0.0184]	[0.0180]	[0.0412]
Male					0.000492	-0.00159	0.00369
					[0.0161]	[0.0164]	[0.0175]
Average Rainfall		0.0867	0.242*	0.321**			
		[0.181]	[0.135]	[0.144]			
Average Temperature		-0.810***	-0.540***	-0.480***			
		[0.268]	[0.148]	[0.174]			
Latitude		-0.237	0.234	-0.121			
		[0.819]	[1.710]	[1.391]			
Land Suitability		0.367***	0.232***	0.207**			
		[0.116]	[0.0842]	[0.0853]			
Share of Carboniferous Area			-0.475***	-0.496***			
			[0.145]	[0.121]			
Maritime Border			-0.0788*	-0.135**		-0.0538	-0.140**
			[0.0462]	[0.0590]		[0.0548]	[0.0641]
Border Border			0.0441	0.0276		0.109*	0.0309
			[0.0483]	[0.0554]		[0.0638]	[0.0974]
Distance to Paris			0.00795	0.0121		-0.0267**	0.00188
			[0.0406]	[0.0379]		[0.0117]	[0.0176]
Paris and Suburbs			0.227***	0.201**		0.121**	0.0774
			[0.0830]	[0.0846]		[0.0577]	[0.0573]
Constant	-0.448***	1.924	-1.607	-1.131	0.546***	0.664***	0.296*
	[0.0995]	[4.118]	[6.922]	[5.860]	[0.0685]	[0.103]	[0.169]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
R2	0.068	0.340	0.475		0.025	0.050	
F-stat				46.159			28.508
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.6. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461*	0.0364	0.0401*	0.116***	0.0452**	0.0314*	0.139**
	[0.0271]	[0.0315]	[0.0238]	[0.0284]	[0.0176]	[0.0188]	[0.0584]
Male					0.000492	-0.00159	0.00369
					[0.0184]	[0.0198]	[0.0189]
Average Rainfall		0.0867	0.242**	0.321***			
		[0.157]	[0.102]	[0.109]			
Average Temperature		-0.810***	-0.540***	-0.480***			
		[0.304]	[0.0754]	[0.0791]			
Latitude		-0.237	0.234	-0.121			
		[0.893]	[1.808]	[1.005]			
Land Suitability		0.367***	0.232***	0.207***			
		[0.128]	[0.0713]	[0.0667]			
Share of Carboniferous Area			-0.475***	-0.496***			
			[0.139]	[0.117]			
Maritime Department			-0.0788	-0.135**		-0.0538	-0.140**
			[0.0482]	[0.0632]		[0.0448]	[0.0681]
Border Department			0.0441	0.0276		0.109*	0.0309
			[0.0306]	[0.0499]		[0.0654]	[0.101]
Distance to Paris			0.00795	0.0121		-0.0267*	0.00188
			[0.0412]	[0.0208]		[0.0145]	[0.0189]
Paris and Suburbs			0.227***	0.201***		0.121*	0.0774
			[0.0535]	[0.0463]		[0.0681]	[0.0563]
Constant	-0.448***	1.924	-1.607	-1.131	0.546***	0.664***	0.296
	[0.126]	[4.363]	[6.783]	[3.938]	[0.0920]	[0.146]	[0.214]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
R2	0.068	0.340	0.475		0.025	0.050	
F-stat							43.734
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.7. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461* [0.0277]	0.0364 [0.0275]	0.0311 [0.0236]	0.0857** [0.0380]	0.0452** [0.0184]	0.0217 [0.0189]	0.0951** [0.0475]
Male					0.000492 [0.0161]	0.000102 [0.0161]	0.00171 [0.0162]
Average Rainfall		0.0867 [0.181]	0.209 [0.151]	0.250 [0.153]			
Average Temperature		-0.810*** [0.268]	-0.543*** [0.0999]	-0.536*** [0.116]			
Latitude		-0.237 [0.819]	-0.939 [1.494]	-1.186 [1.272]			
Land Suitability		0.367*** [0.116]	0.212*** [0.0731]	0.207*** [0.0747]			
Share of Carboniferous Area			-0.413*** [0.142]	-0.426*** [0.114]			
Distance to Sea			0.00755 [0.0171]	0.0180 [0.0172]		0.0103 [0.0142]	0.0259* [0.0133]
Distance to Border			-0.0533** [0.0239]	-0.0389* [0.0225]		-0.0513*** [0.0189]	-0.0222 [0.0273]
Distance to Paris			-0.0273 [0.0377]	-0.0213 [0.0356]		-0.0252** [0.0121]	-0.00295 [0.0157]
Paris and Suburbs			0.197** [0.0781]	0.179** [0.0796]		0.150** [0.0640]	0.114* [0.0678]
Constant	-0.448*** [0.0995]	1.924 [4.118]	3.492 [6.001]	3.851 [5.321]	0.546*** [0.0685]	0.905*** [0.131]	0.399 [0.247]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
R2	0.068	0.340	0.502		0.025	0.058	
F-stat				50.621			23.108
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.8. *The effect of industrialization on the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) IV
	Share of Literate Conscripts Born Between 1839 and 1848				Signature of Wedding License For Individuals Born between 1839 & 1848		
Number of Steam Engines	0.0461*	0.0364	0.0311	0.0857***	0.0452**	0.0217	0.0951*
	[0.0271]	[0.0315]	[0.0236]	[0.0253]	[0.0176]	[0.0179]	[0.0539]
Male					0.000492	0.000102	0.00171
					[0.0184]	[0.0185]	[0.0176]
Average Rainfall		0.0867	0.209***	0.250***			
		[0.157]	[0.0666]	[0.0871]			
Average Temperature		-0.810***					
		[0.304]					
Latitude		-0.237	-0.939	-1.186			
		[0.893]	[1.358]	[0.893]			
Land Suitability		0.367***	0.212***	0.207***			
		[0.128]	[0.0593]	[0.0584]			
Share of Carboniferous Area			-0.413***	-0.426***			
			[0.108]	[0.0778]			
Distance to Border			-0.0533***	-0.0389**		-0.0513**	-0.0222
			[0.0192]	[0.0183]		[0.0214]	[0.0228]
Distance to Sea			0.00755	0.0180**		0.0103	0.0259***
			[0.0111]	[0.00844]		[0.0157]	[0.00822]
Distance to Paris			-0.0273	-0.0213		-0.0252*	-0.00295
			[0.0349]	[0.0236]		[0.0131]	[0.0155]
Paris and Suburbs			0.197***	0.179***		0.150**	0.114*
			[0.0468]	[0.0469]		[0.0759]	[0.0650]
Constant	-0.448***	1.924	3.492	3.851	0.546***	0.905***	0.399**
	[0.126]	[4.363]	[5.163]	[3.551]	[0.0920]	[0.105]	[0.199]
Mean Value of Dependent Variable	0.74	0.74	0.74	0.74	0.71	0.71	0.71
R2	0.068	0.340	0.502		0.025	0.058	
F-stat							26.586
Observations	85	85	85	85	7,158	7,158	7,158
Geographic Characteristics	No	Yes	Yes	Yes	No	No	Yes
Institutional Characteristics	No	No	Yes	Yes	No	Yes	Yes
Birthyear Fixed Effects	No	No	No	No	Yes	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the share of literate conscripts and to the literacy of spouses born between 1839 and 1848, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.9. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.190***	0.320***	0.129***	0.125***	0.137***	0.266***	0.270**	0.148	0.191**	0.424***	-0.921***	-0.708***	-0.654***	-0.896**
	[0.0423]	[0.0351]	[0.0350]	[0.0912]	[0.0287]	[0.0330]	[0.0308]	[0.0671]	[0.109]	[0.0917]	[0.0817]	[0.122]	[0.141]	[0.172]	[0.174]	[0.361]
Average Rainfall		1.019***	1.108***	1.244***		-0.404	-0.486	-0.350		1.041	0.426	0.671		2.474*	2.563	2.309
		[0.327]	[0.286]	[0.278]		[0.278]	[0.306]	[0.355]		[0.689]	[0.534]	[0.591]		[1.497]	[1.706]	[1.827]
Average Temperature		-0.939***	-1.146***	-1.044**		0.554**	0.602**	0.704***		3.257***	2.401***	2.583***		-2.800	-0.256	-0.445
		[0.322]	[0.386]	[0.408]		[0.252]	[0.290]	[0.262]		[0.771]	[0.667]	[0.636]		[1.891]	[1.776]	[1.697]
Latitude		1.007	3.729	3.119		0.0929	4.478**	3.873*		7.992**	17.26***	16.17***		-9.345*	-17.23	-16.10
		[1.056]	[2.931]	[2.577]		[1.403]	[1.917]	[2.026]		[3.151]	[3.340]	[3.794]		[5.535]	[11.34]	[12.96]
Land Suitability		0.459***	0.378**	0.335**		-0.0285	0.0584	0.0153		0.215	0.456	0.378		0.367	-0.337	-0.256
		[0.176]	[0.163]	[0.149]		[0.114]	[0.125]	[0.134]		[0.515]	[0.394]	[0.390]		[0.817]	[0.774]	[0.792]
Share of Carboniferous Area			-0.635**	-0.672**			0.225	0.189			0.198	0.133			-0.733	-0.666
			[0.319]	[0.272]			[0.239]	[0.189]			[0.536]	[0.352]			[1.083]	[0.986]
Maritime Department			0.0926	-0.00365			-0.221**	-0.317***			-0.347*	-0.519***			-0.462	-0.283
			[0.113]	[0.152]			[0.0935]	[0.111]			[0.187]	[0.175]			[0.364]	[0.440]
Border Department			-0.0604	-0.0887			-0.127	-0.155			-0.884***	-0.934***			1.013*	1.065**
			[0.118]	[0.132]			[0.124]	[0.122]			[0.206]	[0.209]			[0.524]	[0.517]
Distance to Paris			0.0928	0.0999			0.142**	0.149**			0.302***	0.315***			-0.342	-0.355
			[0.0910]	[0.0932]			[0.0690]	[0.0728]			[0.0849]	[0.0968]			[0.364]	[0.389]
Paris and Suburbs			0.578***	0.534***			0.466***	0.422***			-1.350***	-1.430***			-1.824**	-1.741*
			[0.169]	[0.161]			[0.145]	[0.156]			[0.297]	[0.344]			[0.833]	[0.930]
Constant	6.080***	-2.465	-13.30	-12.48	6.086***	7.146	-9.722	-8.909	3.432***	-41.59***	-71.83***	-70.36***	5.103***	30.46	55.03	53.51
	[0.142]	[5.372]	[11.76]	[11.11]	[0.0635]	[6.643]	[7.393]	[7.713]	[0.334]	[15.51]	[14.99]	[15.84]	[0.487]	[26.91]	[43.35]	[48.76]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
R2	0.197	0.425	0.505		0.241	0.355	0.452		0.124	0.328	0.498		0.301	0.400	0.447	
1st stage F-stat				46.159				46.159				46.159				46.159
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.10. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV	OLS	OLS	OLS	IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.190***	0.320***	0.129***	0.125***	0.137***	0.266	0.270**	0.148	0.191**	0.424	-0.921***	-0.708***	-0.654***	-0.896***
	[0.0510]	[0.0353]	[0.0274]	[0.0909]	[0.0317]	[0.0324]	[0.0383]		[0.114]	[0.110]	[0.0863]		[0.150]	[0.217]	[0.213]	[0.328]
Average Rainfall		1.019	1.108***	1.244***		-0.404*	-0.486**	-0.350		1.041**	0.426	0.671**		2.474*	2.563	2.309
			[0.235]	[0.204]		[0.243]	[0.211]	[0.264]		[0.411]	[0.438]	[0.306]		[1.484]	[1.987]	[1.977]
Average Temperature		-0.939***	-1.146***	-1.044***		0.554***	0.602	0.704*		3.257***	2.401***	2.583***		-2.800	-0.256	-0.445
		[0.284]	[0.259]	[0.255]		[0.183]	[0.370]	[0.409]		[0.463]	[0.510]	[0.268]		[1.802]	[1.482]	[1.367]
Latitude		1.007***	3.729	3.119*		0.0929	4.478***	3.873**		7.992**	17.26***	16.17***		-9.345*	-17.23	-16.10
		[0.311]	[2.896]	[1.640]		[1.274]	[1.543]	[1.604]		[3.270]	[2.015]	[2.743]		[5.164]	[15.86]	[16.84]
Land Suitability		0.459***	0.378	0.335		-0.0285	0.0584	0.0153		0.215	0.456*	0.378*		0.367	-0.337	-0.256
		[0.105]				[0.122]	[0.127]	[0.127]		[0.297]	[0.233]	[0.227]		[0.728]	[0.742]	[0.816]
Share of Carboniferous Area			-0.635**	-0.672***			0.225	0.189			0.198	0.133			-0.733	-0.666
			[0.293]	[0.257]							[0.306]	[0.262]			[1.077]	[1.124]
Maritime Department			0.0926	-0.00365			-0.221**	-0.317**			-0.347**	-0.519***			-0.462	-0.283
			[0.0843]	[0.113]			[0.109]	[0.138]			[0.159]	[0.125]			[0.487]	[0.566]
Border Department			-0.0604	-0.0887*			-0.127	-0.155			-0.884***	-0.934***			1.013**	1.065**
			[0.0930]	[0.0535]			[0.158]	[0.145]			[0.337]	[0.303]			[0.400]	[0.432]
Distance to Paris			0.0928	0.0999			0.142***	0.149***			0.302***	0.315***			-0.342	-0.355
			[0.101]	[0.0852]			[0.0503]	[0.0518]			[0.0239]	[0.0777]			[0.402]	[0.437]
Paris and Suburbs			0.578***	0.534***			0.466***	0.422***			-1.350***	-1.430***			-1.824***	-1.741***
			[0.143]	[0.0963]			[0.0111]	[0.0883]			[0.0643]	[0.150]			[0.427]	[0.610]
Constant	6.080***	-2.465	-13.30	-12.48***	6.086***	7.146	-9.722	-8.909	3.432***	-41.59***	-71.83***	-70.36***	5.103***	30.46	55.03	53.51
	[0.168]	[1.763]	[9.426]	[4.524]	[0.0788]	[5.510]	[6.298]	[5.803]	[0.354]	[14.20]	[8.472]	[10.57]	[0.562]	[22.83]	[57.98]	[62.03]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
R2	0.197	0.425	0.505		0.241	0.355	0.452		0.124	0.328	0.498		0.301	0.400	0.447	
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.11. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and spatial autocorrelation using spatial* Colella et al. *(2019) standard errors with a radius of 100km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
	Teachers 1840				Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863			
Number of Steam Engines	0.164***	0.211***	0.183***	0.312***	0.129***	0.125***	0.125***	0.250***	0.270**	0.148	0.158	0.432**	-0.921***	-0.708***	-0.729***	-1.097***
	[0.0423]	[0.0351]	[0.0314]	[0.0899]	[0.0287]	[0.0330]	[0.0321]	[0.0905]	[0.109]	[0.0917]	[0.102]	[0.185]	[0.141]	[0.172]	[0.153]	[0.337]
Average Rainfall		1.019***	1.163***	1.260***		-0.404	-0.559	-0.465		1.041	0.357	0.563		2.474*	2.292	2.016
		[0.327]	[0.300]	[0.276]		[0.278]	[0.356]	[0.397]		[0.689]	[0.643]	[0.687]		[1.497]	[1.528]	[1.679]
Average Temperature		-0.939***	-0.918***	-0.902***		0.554**	0.558*	0.574*		3.257***	3.006***	3.040***		-2.800	-0.381	-0.427
		[0.322]	[0.338]	[0.346]		[0.252]	[0.285]	[0.296]		[0.771]	[0.805]	[0.822]		[1.891]	[1.702]	[1.715]
Latitude		1.007	2.132	1.552		0.0929	2.709*	2.148		7.992**	9.984**	8.750*		-9.345*	-25.53**	-23.87*
		[1.056]	[2.414]	[2.118]		[1.403]	[1.631]	[1.670]		[3.151]	[4.460]	[4.804]		[5.535]	[11.67]	[12.76]
Land Suitability		0.459***	0.305*	0.292*		-0.0285	0.0749	0.0625		0.215	0.369	0.341		0.367	-0.570	-0.533
		[0.176]	[0.169]	[0.163]		[0.114]	[0.139]	[0.150]		[0.515]	[0.459]	[0.447]		[0.817]	[0.706]	[0.740]
Share of Carboniferous Area			-0.546	-0.576**			0.343	0.313			0.728	0.663			-0.364	-0.276
			[0.349]	[0.282]			[0.284]	[0.230]			[0.721]	[0.528]			[1.141]	[1.023]
Distance to Border			-0.0757*	-0.0418			0.0142	0.0469			0.0333	0.105			-0.658**	-0.754**
			[0.0450]	[0.0555]			[0.0523]	[0.0662]			[0.144]	[0.158]			[0.266]	[0.301]
Distance to Sea			-0.0434	-0.0188			0.0340	0.0578*			0.00155	0.0538			0.0445	-0.0257
			[0.0370]	[0.0425]			[0.0264]	[0.0301]			[0.0966]	[0.106]			[0.163]	[0.170]
Distance to Paris			0.0290	0.0431			0.0928	0.106*			0.0520	0.0820			-0.586	-0.626
			[0.0764]	[0.0804]			[0.0613]	[0.0634]			[0.117]	[0.125]			[0.390]	[0.406]
Paris and Suburbs			0.533***	0.492***			0.422***	0.382***			-1.560***	-1.649***			-2.037**	-1.917**
			[0.150]	[0.148]			[0.137]	[0.148]			[0.323]	[0.372]			[0.806]	[0.898]
Constant	6.080***	-2.465	-7.265	-6.419	6.086***	7.146	-2.442	-1.625	3.432***	-41.59***	-44.38**	-42.58*	5.103***	30.46	93.25*	90.84*
	[0.142]	[5.372]	[9.920]	[9.366]	[0.0635]	[6.643]	[6.868]	[6.911]	[0.334]	[15.51]	[21.26]	[22.15]	[0.487]	[26.91]	[49.47]	[53.21]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
R2	0.197	0.425	0.513		0.241	0.355	0.418		0.124	0.328	0.420		0.301	0.400	0.479	
1st stage F-stat				50.621				50.621				50.621				50.621
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 100km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table F.12. *The effect of industrialization on the number of primary schoolteachers in 1840 and on public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and spatial autocorrelation using spatial Colella* et al. *(2019) standard errors with a radius of 250km*

	(1) OLS	(2) OLS	(3) OLS	(4) IV	(5) OLS	(6) OLS	(7) OLS	(8) IV	(9) OLS	(10) OLS	(11) OLS	(12) IV	(13) OLS	(14) OLS	(15) OLS	(16) IV
			Teachers 1840			Commune Spending on Primary Schooling per Inhabitant, 1855-1863				Department Spending on Primary Schooling per Inhabitant, 1855-1863				Central State Spending on Primary Schooling per Inhabitant, 1855-1863		
Number of Steam Engines	0.164***	0.211***	0.183***	0.312***	0.129***	0.125***	0.125***	0.250***	0.270**	0.148	0.158	0.432***	-0.921***	-0.708***	-0.729***	-1.097***
	[0.0510]	[0.0353]	[0.0162]	[0.0732]	[0.0317]	[0.0324]	[0.0385]	[0.0337]	[0.114]	[0.110]	[0.131]	[0.141]	[0.150]	[0.217]	[0.165]	[0.206]
Average Rainfall		1.019	1.163***	1.260***		-0.404*	-0.559**	-0.465		1.041**	0.357	0.563		2.474*	2.292	2.016
			[0.188]	[0.176]		[0.243]	[0.241]	[0.300]		[0.411]	[0.398]	[0.367]		[1.484]	[1.658]	[1.693]
Average Temperature		-0.939***	-0.918***	-0.902***		0.554***	0.558**	0.574**		3.257***	3.006***	3.040***		-2.800	-0.381	-0.427
		[0.284]	[0.195]	[0.143]		[0.183]	[0.235]	[0.240]		[0.463]	[0.530]	[0.336]		[1.802]	[1.433]	[1.319]
Latitude		1.007***	2.132	1.552*		0.0929	2.709**	2.148***		7.992**	9.984**	8.750*		-9.345*	-25.53***	-23.87**
		[0.311]	[1.591]	[0.931]		[1.274]	[1.280]	[0.231]		[3.270]	[4.121]	[4.696]		[5.164]	[9.319]	[9.350]
Land Suitability		0.459***	0.305	0.292		-0.0285	0.0749	0.0625		0.215	0.369**	0.341		0.367	-0.570	-0.533
		[0.105]				[0.122]	[0.129]	[0.126]		[0.297]	[0.171]	[0.221]		[0.728]	[0.691]	[0.758]
Share of Carboniferous Area			-0.546*	-0.576**			0.343	0.313***			0.728	0.663			-0.364	-0.276
			[0.283]	[0.246]				[0.0515]			[0.553]	[0.527]			[0.693]	[0.798]
Distance to Border			-0.0757***	-0.0418***			0.0142	0.0469			0.0333	0.105			-0.658***	-0.754***
			[0.0133]	[0.0150]			[0.0596]	[0.0671]			[0.189]	[0.184]			[0.188]	[0.174]
Distance to Sea			-0.0434***	-0.0188			0.0340	0.0578			0.00155	0.0538			0.0445	-0.0257
			[0.00873]				[0.0374]	[0.0358]			[0.117]	[0.112]			[0.116]	[0.0849]
Distance to Paris			0.0290	0.0431			0.0928	0.106***			0.0520	0.0820			-0.586**	-0.626***
			[0.0649]	[0.0636]			[0.0594]	[0.0301]			[0.117]	[0.125]			[0.266]	[0.227]
Paris and Suburbs			0.533***	0.492***			0.422***	0.382***			-1.560***	-1.649***			-2.037***	-1.917***
			[0.0967]	[0.0508]			[0.0466]	[0.0955]			[0.176]	[0.246]			[0.280]	[0.537]
Constant	6.080***	-2.465	-7.265*	-6.419	6.086***	7.146	-2.442	-1.625	3.432***	-41.59***	-44.38**	-42.58**	5.103***	30.46	93.25**	90.84**
	[0.168]	[1.763]	[4.311]		[0.0788]	[5.510]	[5.523]	[1.085]	[0.354]	[14.20]	[19.67]	[20.54]	[0.562]	[22.83]	[37.36]	[37.63]
Mean Value of Dependent Variable	742	742	742	742	0.65	0.65	0.65	0.65	0.08	0.08	0.08	0.08	0.10	0.10	0.10	0.10
R2	0.197	0.425	0.513		0.241	0.355	0.418		0.124	0.328	0.420		0.301	0.400	0.479	
Observations	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
Geographic Characteristics	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Institutional Characteristics	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes

Note: This table presents OLS and IV regressions relating the number of steam engines in 1839-1847 to the number of primary schoolteachers in 1840 and to public spending on education from the three tiers of the government (communes, departments, central state) during the 1855-1863 period, accounting for distances to sea and border and for spatial autocorrelation using Colella *et al.* (2019)'s spatial standard errors with a radius of 250km. The relationship accounts for geographic and institutional characteristics. Geographic characteristics include the department's latitude, land suitability, average rainfall and average temperature. Institutional measures include the distance to Paris, the share of carboniferous area and dummies for maritime and border departments as well as for Paris and its suburbs. Heteroskedasticity-robust standard errors are reported in brackets. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Appendix G. Human Capital in the Process of Industrialization in France

France was one of the first countries to industrialize in Europe in the 18th century and its industrialization continued during the 19th century. However, by 1914, its living standards remained below those of England and it had been overtaken by Germany as the leading industrial country in continental Europe. The slower path of industrialization in France has been attributed to the consequences of the French Revolution (e.g., wars, legal reforms and land redistribution), the patterns of domestic and foreign investment, cultural preferences for public services, as well as the comparative advantage of France in agriculture vis-a-vis England and Germany (see the discussion in, e.g., Lévy-Leboyer and Bourguignon, 1990; Crouzet, 2003).

G.1. Schooling in France before and during the Industrial Revolution

Prior to the French Revolution in 1789, the provision of education in the contemporary French territory was predominantly left to the Catholic Church, reflecting the limited control of the central government and the lack of linguistic unity across the country (Weber, 1976). However, the evolution of state capacity, national identity, and linguistic uniformity over the centuries intensified the involvement of the state in the provision of education while diminishing the role of the Church during the 19th century.

G.1.1. Education in Early Modern France

Until the rise of Protestantism in the 16th century, the Catholic Church mainly provided education to the privileged members of society (Rouche, 2003). However, the spread of Protestantism, and

the rise in the emphasis on literacy as a means to understand the Holy Scripture, had altered the attitude of the Catholic Church with respect to the provision of education. The Catholic educational system then progressively became intertwined with its mission of salvation. As such, several religious orders viewed education as their principal mission. The Jesuits had gradually focused their efforts on the education of children from the aristocratic classes while the Frères des Ecoles Chrétiennes (Brothers of Christian Schools) led by Jean-Baptiste de la Salle (1651-1719) sought to provide free education to the masses. Moreover, female religious communities (e.g., Ursulines, Filles de la Charité) provided schooling for girls.

The nature of the education provided by the Church over this period was not subjected to interference from the central government. In fact, except for the universities which were controlled by the State from the late 16th century onwards, the various Catholic orders had built an education system which was independent from the French kings.[24] However, the monopoly of the Church in the provision of education abruptly ended with the French Revolution in 1789.

G.1.2. Education after the 1789 French Revolution

The transformation of French society triggered by the French Revolution in 1789 affected the provision of education as well. Article 22 of the Declaration of the Rights of Man and of the Citizen in 1793 explicitly stated that education is a universal right. Nevertheless, the Constitution of the First French Republic (1792-1799) did not underline the role of state-funded secular education. The attacks of the French Revolutionaries against the Catholic Church, exemplified by the confiscation of its property and the imprisonment and execution of priests, impaired the Church's ability to remain

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[24]Nevertheless, some conflicts over the nature of schooling took place between the Jesuits and the Universities as well as between various religious Congregations. In particular, the Jesuits were expelled by King Louis XV in 1764 and their school network was overtaken by the Oratorians.

the main provider of education, but secular education was nonetheless slow to emerge (Godechot, 1951).

The rise of Napoleon Bonaparte to power (1799-1815) and his interest in preventing hostile relationships with Rome, permitted the Church to regain a prominent position in the provision of education in France.[25] According to the 17 March 1808 decree on education, the Frères des Ecoles Chrétiennes were left in charge of primary schooling and of training teachers while school curriculum was to be conform to the teachings of the Catholic Church. However this decree also created a secular body – the *Université* – that was assigned the management of public (secular) education. Throughout the 19th century, the *Université* would try to counter the Church's influence in the education system (Mayeur, 2003).

After Napoleon's fall in 1815, the accession to power of King Louis XVIII (1815-1824), from the senior branch of the Bourbon family, initially strengthened the educational monopoly of the Church. In particular, the 29 February 1816 law required local priests to certify the morality of primary school teachers. However, after the 1827 parliamentary election of a more liberal government, primary school teachers were placed under the authority of the *Université*, against the wishes of the Church.

The 1830 Revolution which overthrew King Charles X (1824-1830), Louis XVIII's brother and successor, installed King Louis-Philippe I (1830-1848), from the cadet Orléans branch of the Bourbon family. Many influential members of the new regime were members of the liberal bourgeoisie and were rather hostile to the Catholic Church. This led Catholics to lobby for an educational network of their own outside the control of the State, under the guise of "freedom of education".

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[25]This state of affairs suited Napoleon Bonaparte because the Concordat (the 1801 treaty which he had signed with Pope Pius VII and which structured the relationship between the French State and the Church), provided him control over the appointment of bishops.

Ultimately, François Guizot, King Louis-Philippe I's Prime Minister, enacted the 28 June 1833 law which reshaped schooling in France and enabled the Church to organize its own private education system. In addition, the Church retained its influence over the curriculum of public schools (e.g., religious instruction remained mandatory while the Frères des Ecoles Chrétiennes were often employed as teachers in public schools). The organization of secondary schooling then became the main point of contention between the Church and its opponents. However it was only after the fall of Louis-Philippe I in 1848 and the establishment of the Second Republic (1848-1851) that the Church was allowed to organize its own network of secondary schools while obtaining subsidies from the State and local governments (15 March 1850 law enacted by Education minister Alfred de Falloux). Moreover towns were not compelled to fund a public primary school if there was already a private (i.e., Catholic) school in their jurisdiction, and teachers had to fulfill the religious duties prescribed by the Church (27 August 1851 regulation).

Interestingly enough, technical education was less of a battleground between the State and the Church than general primary schooling. This might have been due to the lesser importance of technical education in a period where training on the job was widespread. Nonetheless the 28 June 1833 law which reshaped schooling in France also established "schools of higher primary education" that provided the basics of technical education (Marchand, 2005). But it took another 18 years before the 22 February 1851 law formally established schools for apprentices. Still, a decade later, few students attended these technical schools and most of those who did were enrolled in public schools, not in religious schools (France, 1865). Conversely, in the 1850s and early 1860s, enrollment in Catholic primary schools, especially for girls, was growing at the expense of enrollment in public primary schools. This led Victory Duruy, the education minister of Napoleon III (1851-1870) after 1863, to counter the decline in public schooling, thereby initiating a conflict between

Catholics and secular politicians which would reach its climax after the establishment of the Third Republic in 1875 (Mayeur, 2003; Franck and Johnson, 2016; Franck and Galor, 2021).

G.2. Literacy Rates in France

In spite, or because of, the struggle between Church and State in France during the 19th century, the evolution of literacy and its distribution across French departments is rather notable in the course of industrialization. In 1686-1690, prior to the onset of the industrial revolution in France, 25.9% of grooms could sign their names, reflecting substantial variations in literacy across France as depicted in Panel A of Figure A.6.[26] In particular, literacy rates were higher in the regions in the North, North-East and South-East of France.

Literacy rates had steadily increased in the subsequent century and 42% of grooms could sign their names in 1786-1790 and 50.61% in 1816-1820, in spite of the Revolutionary and Napoleonic wars. As depicted in Panels B and C of Figure A.6 regional variations across France remained and the domination of the Northern and the Eastern regions persisted. However, literacy rates in some departments had evolved faster than in others, notably in the South (e.g., Aveyron) and the South East along the Mediterranean Sea (Bouches du Rhône, Var). Moreover, the potential association between industrialization and literacy is rather apparent. In particular, Aveyron, Bouches du Rhône and Var were among the most industrialized departments in the South of France.[27]

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[26]Data on literacy in France before the mid-19th century is scarce and incomplete. There is however data on the number of Frenchmen who could sign their marriage license in 1686-1690, 1786-1790 and 1816-1820 as discussed by Furet and Ozouf (1977). For the 1686-1690 period, there are no observations for Aveyron, Bas-Rhin, Dordogne, Indre-et-Loire, Lot, Lozère, Haut-Rhin, Lot, Seine and Vendée. For the 1786-1790 period, observations are missing for for Bas-Rhin, Dordogne, Haut-Rhin, Lot, Seine and Vendée. For the 1816-1820 period, observations are missing for Bas-Rhin, Dordogne, Haut-Rhin, Lot, Morbihan, Seine and Vendée.

[27]For a discussion of the cultural, religious and economic factors which could explain the regional differences in the share of literate grooms, see notably Furet and Ozouf (1977), Grew and Harrigan (1991) and Diebolt *et al.* (2005).

The increase in literacy rates continued throughout the 19th century so that the share of French conscripts (i.e., 20-year old men reporting for military service in the department where their father lived) who could read and write grew from 54.27% in 1838 to 84.83% in 1881. Thus, a significant fraction of Frenchmen were literate even before the adoption of the 1881-1882 laws on mandatory and free public schooling (Diebolt *et al.*, 2005).
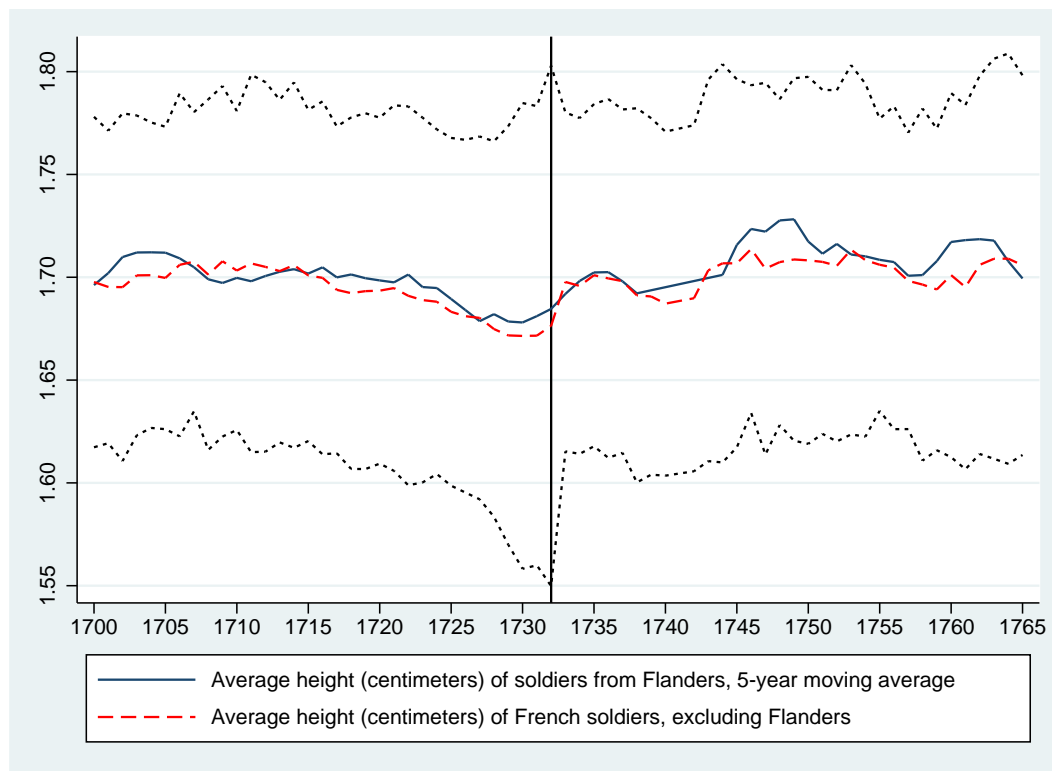
Appendix H. Average Height of Soldiers in France, 1700-1765

Figure H.1. *Average height of soldiers in France, 1700-1765*

Note: This figure displays the average mean height of soldiers from Flanders and from the rest of France. The interval between the dotted lines reflects the standard deviation around the national average (excluding Flanders). The vertical line marks the year 1732 when the first commercial application of the steam engine was made in France.

Appendix I. Variable Definitions and Sources

Dependent variables

Literate conscripts

Share of literate individuals among conscripts born between 1827 and 1836 as well as between 1839 and 1848. The average 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 and who were born between 1827 and 1836 as well as between 1839 and 1848. Source: France. Ministère de la guerre (1791-1936) - Compte rendu sur le recrutement de l'armée.

Middle- and High-School Pupils

Middle- and High-School Pupils, 1842. Share of pupils enrolled in middle- and high-school in each arrondissement out of the total population. Source: France. Statistique de l'enseignement secondaire (1843).

Public Spending on Education

Commune Spending on Primary Schooling per Inhabitant, 1855-1863. 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.

Department Spending on Primary Schooling per Inhabitant, 1855-1863. 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.

Central State Spending on Primary Schooling per Inhabitant, 1855-1863. 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.

Pupils

Pupils, 1840. Share of pupils enrolled in primary schools out of the population age 5-15 in the 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.

Signature of Wedding License For Individuals Born between 1839 & 1848

Signature of Wedding License For Individuals Born between 1839 & 1848: This dummy variable takes the value one if an individual born between 1839 & 1848 could sign his/her wedding license. Source: Bourdieu, Jérôme, Lionel Kesztenbaum and Gilles Postel-Vinay, L'enquête TRA, histoire d'un outil, outil pour l'histoire, INED, Paris (2014).

Male: This dummy variable takes the value one if an individual born between 1839 & 1848 was a man could sign his/her wedding license. Source: Bourdieu, Jérôme, Lionel Kesztenbaum and Gilles Postel-Vinay, L'enquête TRA, histoire d'un outil, outil pour l'histoire, INED, Paris (2014).

Teachers

Teachers, 1840. Number of teachers in primary schools. 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.

Explanatory variables

Horse power of steam engines. This variable reports the number of steam *Engines* in the firms of each department, which is computed from the industrial survey carried out by the French government between 1839 and 1847. See Chanut *et al.* (2000) for details on the implementation of this survey.

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

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

Border department. This dummy variable takes the value one if a French department borders one of the foreign countries around France (Belgium, Luxembourg, Germany, Switzerland, Italy and Spain) and zero otherwise.

Border arrondissement. This dummy variable takes the value one if a French arrondissement borders one of the foreign countries around France (Belgium, Luxembourg, Germany, Switzerland, Italy and Spain) and zero otherwise.

Distance to Paris. The great circle distance as "the crow flies" from Paris, the capital of France, to the administrative center of each department (or arrondissement). This aerial distance is computed in 100 km.

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

Latitude. The latitude of the centroid of each French department (or arrondissement).

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

Maritime arrondissement. This dummy variable takes the value one if a French arrondissement 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.

Share of carboniferous area . The share of carboniferous area in each department (or arrondissement). Source: Fernihough and O'Rourke (2021).

Male. This dummy variable takes the value one if an individual born between 1839 & 1848 is a man. Source: Bourdieu, Jérôme, Lionel Kesztenbaum and Gilles Postel-Vinay, L'enquête TRA, histoire d'un outil, outil pour l'histoire, INED, Paris (2014).

Instrumental variables

Distance to Fresnes-sur-Escaut. The great circle distance "as the crow flies from" Fresnes-sur-Escaut, where the first team engine was operated in France in 1732, to the administrative center of each department (or arrondissement). This aerial distance is computed in kilometers.

(Standardized) Net Increase in Wheat Prices in 1834-1838 (baseline 1819-1833). Deviation from trend in yearly wheat prices in each department. Source: Labrousse *et al.* (1970).

Variables for robustness analysis

Economic development and market integration before 1839

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).

Trade cost shock (Napoleon's Blockade): Trade cost shock caused by Napoleon's continental blockade. Source: Juhasz (2018).

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

Presence of iron forges, 1789 and 1811. The dummy variable takes the value 1 if there was at least one iron forge in a department in 1789. Source: Woronoff (1997).

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.

Share of department's territory covered by road network, 1837. The area covered by roads in 1837 in each department. Source: Tableau 12, Table général par départements, de l'étendue des communications, par terre et par eau, existant en France, au commencement de 1837. Source: France - Ministère des Travaux Publics (1837). Statistique de la France, Paris.

Share of department's territory covered by water network, 1837. The area covered by the water network in 1837 in each department. Source: Tableau 12, Table général par départements, de

l'étendue des communications, par terre et par eau, existant en France, au commencement de 1837. Source: France - Ministère des Travaux Publics (1837). Statistique de la France, Paris.

Primary schooling in 1833

Communes with school: Number of communes with at least one primary school in each department in 1833. Source: Montalbo (2021).

Total number of schools: Total number of primary schools in each department in 1833. Source: Montalbo (2021).

Total number of schools per inhabitant: Total number of primary schools per inhabitant in each department in 1833. Source: Montalbo (2021).

Human capital before 1820

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.

Encyclopédie subscribers. The number of subscribers to the Quarto edition of the Encyclopédie in the second half of the 18th century in the French towns aggregated at the department level. Source: Darnton (1973), Squicciarini and Voigtländer (2015).

University in 1700. This dummy variable takes the value 1 if a university was located in the department in 1700. Source: Frijhoff (1996).

Distance to University in 1700. The great circle distance as "the crow flies" from the town with a university in 1700 to the administrative center of each department (or arrondissement). This aerial distance is computed in 100 km. Source: Own computations based on Frijhoff (1996).

Population density

Population density, 1801 and 1821. 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.

Railroad connection

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

Urban population in 1700

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).

Distance to London

Distance to London. The great circle distance "as the crow flies" from London to the administrative center of each department (or arrondissement). This aerial distance is computed in kilometers.

Distance to Border

Distance to Border. The road distance from the administrative center of each department (or arrondissement) to the border. This aerial distance is computed in kilometers.

Distance to Sea

Distance to Sea. The road distance "from the administrative center of each department (or arrondissement) to the sea. This aerial distance is computed in kilometers.

Trade cost shock

Trade cost shock (Napoleon's Blockade): Trade cost shock caused by Napoleon's continental blockade. Source: Juhasz (2018)

Past level of fertility

Fertility, 1806. Fertility in each department, computed following the methodology of the Coale fertility index. 1806 is the earliest year available. Source: Bonneuil (1997).

Squared Summer Rainfall Standardized Deviation 1834-1838 (baseline 1819-1833)

Squared Rainfall Standardized Deviation 1834-1838 (baseline 1819-1833). Squared deviations of rainfall in summer 1834-1838 where 1819-1833 is the baseline period. The data are reconstructed by Luterbacher *et al.* (2004), Luterbacher *et al.* (2006) and Pauling *et al.* (2006) for the 1500-1900 period, at a resolution of 0:5 by 0:5 decimal degrees.

Distance to French cities

Distance to Marseille. The great circle distance "as the crow flies" from Marseille to the administrative center of each department (or arrondissement). This aerial distance is in 100 km.

Distance to Lyon. The great circle distance "as the crow flies" from Lyon to the administrative center of each department (or arrondissement). This aerial distance is in 100 km.

Distance to Rouen. The great circle distance "as the crow flies" from Rouen to the administrative center of each department (or arrondissement). This aerial distance is in 100 km.

Distance to Mulhouse. The great circle distance "as the crow flies" from Mulhouse to the administrative center of each department (or arrondissement). This aerial distance is in 100 km.

Distance from Paris (weeks of travel). The time needed for a surface travel from Paris to the administrative center of each department (or arrondissement) measured in weeks of travel. Source: Özak (2018).

Distance from Marseille (weeks of travel). The time needed for a surface travel from Marseille to the administrative center of each department (or arrondissement) measured in weeks of travel. Source: Özak (2018).

Distance from Lyon (weeks of travel). The time needed for a surface travel from Lyon from Lyon to the administrative center of each department (or arrondissement) measured in weeks of travel. Source: Özak (2018).

Distance from Rouen (weeks of travel). The time needed for a surface travel from Rouen to the administrative center of each department (or arrondissement) measured in weeks of travel. Source: Özak (2018).

*Distance from Mulhouse (weeks of travel).*The time needed for a surface travel from Mulhouse to the administrative center of each department (or arrondissement) measured in weeks of travel. Source: Özak (2018).

Agriculture

Share of Day Agricultural Laborers in Population . Share of day agricultural laborers in population in 1852. Source: Marin Béatrice and Mathieu Marraud. 2011. L'enquête agricole de 1852, L'Atelier du Centre de recherches historiques, http://journals.openedition.org/acrh/3696.

Payment-in-Kind 1852, Male/Female Servant. Value of payment-in-kind of male/female servants in 1852. Source: Marin Béatrice and Mathieu Marraud. 2011. L'enquête agricole de 1852, L'Atelier du Centre de recherches historiques, http://journals.openedition.org/acrh/3696.