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The Impact of Industrialization on Secondary Schooling during the Industrial Revolution: Evidence from 19th Century France

Abstract

This study explores the impact of industrialization on secondary schooling in 19th century France. As a source of exogenous variation in industrialization across the French territory, it takes advantage of the openings and closures of mines which were supervised by the Ministry of Public Works, independently from the Ministry of Education. The results suggest that industrialization had a negative but mostly insignificant effect on high-school enrollment. However, industrialization increased the share of high-school pupils in applied sections and the wages of mathematics teachers.

JEL-Codes: I250, N330, O140.

Keywords: horse power, industrial revolution, secondary schooling.

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1 Introduction

Recent research (e.g., Atack et al., 2019, Franck and Galor, 2022) suggests that technology adoption during the industrial revolution in the 19$^{\text{th}}$ century was not a deskilling process but actually fostered primary school enrollment and literacy skills in the population.[1] Nonetheless, the consensus remains that industrialization had either an insignificant or even a detrimental effect on high-school enrollment in Western Europe and in the USA during the 19$^{\text{th}}$ century (Goldin and Katz, 1997, Becker et al., 2011).[2] Indeed, just like in many developing countries nowadays (e.g., Atkin, 2016), pursuing high-school studies in the 19$^{\text{th}}$ century implied three or four years of foregone wages in the workplace where training on the job was common and began at age 14 (Mayeur, 2003).[3]

This study explores the impact of industrialization on secondary schooling in 19$^{\text{th}}$ century France. It relies on the surveys of secondary schooling carried out by the French Ministry of Education in 1865, 1876 and 1887. Those data enable us to assess the enrollment in male high-schools, and in particular on enrollment in scientific and literary sections, on the number and wages of high-school teachers as well as on the budgets of high-schools. The study also relies on the data from the French Ministry of Public Works to assess the horse power of steam engines in the mining sector in the administrative unit (known as *département*) of the French territory where high-schools were located.[4] As a source of exogenous variations in the number of steam engines in the mining sector, the empirical analysis uses the number of operating mines in each *département* since they were supervised by an office within the Ministry of Public Works known as the *Inspection Générale des Mines* (General Inspection of Mines) and independently from the Ministry of Education.

The focus on mining in this study is motivated by its importance for French industrial development in the second half of the 19$^{\text{th}}$ century. This is because mining used the "general purpose technology"of the first industrial revolution, i.e., the steam engine, to produce the "general purpose material"of the second industrial revolution, i.e., steel (e.g., Mokyr, 1990, Bresnahan and Trajtenberg, 1995, Crafts, 2005). Additional anecdotal evidence attest to the importance of mining in 19$^{\text{th}}$ century France. For instance, the *Ecole des Mines* (Mining School) became the most sought out specialization for the engineers who graduated from the prestigious *Ecole Polytechnique*: it enabled them to enter the *Inspection Générale des Mines*, and afterwards, gave them the possibility of obtaining very lucrative managerial positions in private sector industries, notably but not only in the

[1] Esposito and Abramson (2021) and Franck and Galor (2021) discuss the long-term negative implications of the industrialization on human capital formation and income.

[2] Semrad (2015) takes a different perspective by showing that in 19$^{\text{th}}$ c. Prussia, high-schools which promoted practical and business-related knowledge fostered growth at the city-level.

[3] Child labor, i.e., for children less than eight years old, had been prohibited in 1841 in France. On this issue, see Shanan (2023) for a recent study and the references therein.

[4] The borders of *départements* were not correlated with industrialization: they were delineated in 1790 to be of small size so that it would take at most one day of horse travel between any location in a *département* and its main administrative center.

mining sector (Chesneau, 1911, Charle, 1987, Chatzis, 2009). Furthermore, mining is the principal industry in Emile Zola's famous novel *Germinal* which deals with the life of workers in the North of France in the 1860s (Zola, 1885).

In addition, the historical context of secondary schooling in 19$^{\text{th}}$ century France enables us to focus on the economic impact of industrialization and somewhat overlook political economy considerations. Indeed, the content and the funding for secondary schooling were relatively spared from the political struggle between the Catholic Church and the State, unlike those for primary schooling (e.g., Franck, 2016, Franck and Johnson, 2016, Squicciarini, 2020, Bignon and Garcia-Peñalosa, 2021). This was naturally because many Frenchmen attended primary school, even episodically, while few attended high-school.[5] It is, of course, possible that religiosity (or lack thereof) had an impact on the decision of parents to let their children attend high-school (Lecce et al., 2021) and this is why the empirical analysis includes a measure of religiosity (i.e, the local number of male Catholic priests), in addition to economic variables such as GDP per capita.

The results suggest that industrialization had a negative and mostly insignificant effect on high-school enrollment. However, industrialization increased the share of high-school pupils in applied sections and the wages of mathematics teachers. Namely, a 1% increase in the log of steam engines in a *département* is associated with a 7.09% increase in the share of high-school pupils in the applied curriculum out of the total number of high-school pupils and a 22.9% increase in the wages of mathematics teachers.

The remainder of this study is as follows. Section 2 provides the data and Section 3 presents the empirical methodology. Section 4 analyzes the results and Section 5 concludes.

2 Data

2.1 High-school education

Data on high-school pupils, teachers and budgets are taken from the three volumes of the *Statistique de l'Enseignement Secondaire*, an official publication of the French Education Ministry published in 1865, 1876 and 1887. At that time, high-school education was reserved to a limited number of pupils whose parents could fund their long-run studies, and to a subset of gifted pupils who received scholarships from one of the three tiers of the French government, i.e., the central state, the *départements* and the *communes*. Indeed, the percentage of high-school pupils out of the male

[5] A supplementary reason for the less intense conflict between the Catholics and the proponents of secular education regarding secondary schooling was the 15 March 1850 law which eased the conditions for opening a private secondary school: this was allowed to anyone who was French, was at least 25-years old, had a *baccalauréat*, i.e., a high-school degree, and had held a position in private or public school during five years. However, as discussed by Mayeur (2003, pp. 517-528), most of the private secondary schools were not always teaching secondary school material and their existence was short-lived.

population age 15-18 amounted to 1.44% in 1865, 1.65% in 1876 and 1.79% in 1887. Moreover, the percentage of pupils with a scholarship out of the total number of high-school pupils was 4.21% in 1865, 6.12% in 1876 and 11.77% in 1887.[6]

There were 334 high-schools in 1865, 336 in 1876 and 350 in 1887. Some of those schools opened while other closed so that there are 394 distinct high-schools in our sample. Aside from Paris (which had 7 high-schools in 1865, 6 in 1876 and 10 in 1887), all other French towns either had one or zero high-school. Overall, *départements* had on average 3.8 high-schools (std. dev. 2.2) throughout the period .

These high-schools were of two different types: *lycées* functioned as boarding schools of a near military kind while *collèges* where only some, but not all, pupils lived on the premises.[7] There was a slight decrease in the number of *collèges* from 252 in 1865 to 249 in 1876 and 241 in 1887 and a slight increase in the number of *lycées* from 82 to 87 and 109 as some *collèges*, which were mainly funded by the local governments, became more prestigious *lycées* where the central state increased its share of funding. Budgets of *collèges* and *lycées* also depended on the tuition fees paid by the parents of high-school pupils. These budgetary differences constrained principals in hiring professors, but also gave them some leeway in paying different wages to high-school teachers by seniority and subject. Indeed, the average yearly wages for foreign language teachers in 1865 and 1876 were 297.15 and 304.13 francs while those of physics teachers were 534.82 and 972.21 francs (data are not available for 1887).

Both *collèges* and *lycées* offered two types of curriculum: *enseignement classique* (classic curriculum) and *enseignement spécial* (special curriculum). The *enseignement classique* included traditional teaching subjects and ultimately prepared for entrance in universities and in other post-secondary institutes of higher learning (known as the *grandes écoles*). It was itself subdivided between a "literary section"where Greek and Latin were taught and a "mathematical section", which focused on theoretical courses in mathematics and physics. A feature of the *enseignement classique* was its neglect of foreign languages.

The *enseignement spécial* was organized at the national level by a law enacted on 21 June 1865 to rationalize the already existing high-schools funded by the local governments, i.e., the *départements* and the *communes*. The then Minister of Education Victor Duruy called it "special"because the curriculum was to be slightly more applied and was to reflect the knowledge and techniques used in the dominant industry in every area, unlike the *enseignement classique* which was to be identical throughout the country. Like the *enseignement classique*, the *enseignement*

[6]The raw numbers are as follows: there were 63500 high-school pupils in 1865, 76257 in 1876 and 86723 in 1887 while the male population age 15-18 amounted to 4,417,148, 4,613,208 and 4,838,599 respectively; only 2673 scholarships were given in 1865, 4665 in 1876 and 10203 in 1887.

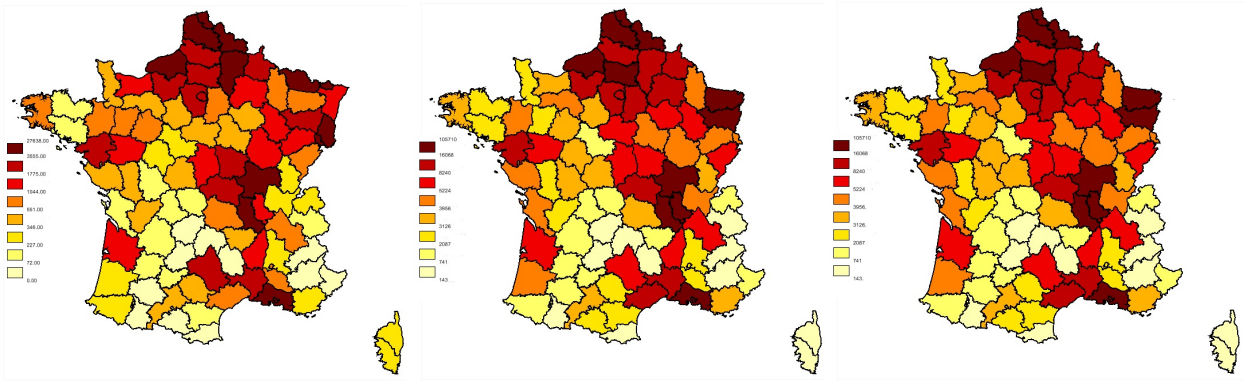
[7]The terms *collèges* and *lycées* in the 19th century should not be confused with the modern terms within the current organization of secondary schooling in France whereby *collèges* cover grades 6 to 9 while *lycées* cover grades 10 to 12.

spécial enabled the pursuit of university education. In that sense, it must be emphasized that the *enseignement spécial* was not a "technical" or "vocational" curriculum. In fact, vocational teaching in 19th century France was neglected by both the central state and the local governments. This might not be surprising an era where training on the job was common (Marchand, 2005). In other words, the *enseignement spécial* was created to rationalize the already existing local curricula and enable the French state to harmonize different practices: the policy decision made in Paris reflected the choices about human capital formation which had already been made by local families (Duruy, 1901, Vol.1, pp.167-168).

2.2 Steam engines and mines in activity

The *Statistique Générale de l'Industrie Minérale* is an official publication of the French Ministry of Public Works that provides data on the numbers of active mines and steam engines in the mining industry in each *département*. While there were 4502 active mines in 1865, 863 in 1876 and 1364 in 1887, the horse power of steam engines increased from 163,702 hp in 1865 to 424,578 hp in 1876 and 745,465 hp in 1887. These numbers reflect the risks associated with the mining sector as well as the increase in its concentration throughout the 19th century. It is also likely that the drop in the number of mines between 1865 and 1876 stemmed from the destruction caused by the French-Prussian war in 1870-1871 and the loss of three French departments (Moselle, Bas-Rhin and Haut-Rhin) to Prussia.

As Figure 1 shows, some areas were more industrialized than others: the *département* of Nord in the North of France was the most industrialized area and concentrated about 15% of the total horsepower of French industry throughout the period.



1865 1876 1885

Figure 1: Horse Power, 1865, 1876 & 1887

2.3 GDP per capita, local religiosity and geographic variables

The analysis includes a set of control variables. It relies on the data on GDP per capita in each *département* computed by Bazot (2014). It also accounts for local religiosity at the *département* level: the number of male Catholic clergymen taken from the successive surveys of the French population. This variable captures the impact of religiosity on the parents' decision to enable their children to study in high-school.

Moreover, as we discuss below, the empirical strategy relies on a panel data approach with fixed effects to account for the invariant characteristics of the *départements* such as their geographic features. It is however possible that these invariant characteristics might have a different impact over time, especially if they were correlated with technology adoption. Therefore, our empirical analysis includes interaction variables between year-fixed effects and specific geographic variables whose impact might have changed over time. We thus use the share of carboniferous area in each *département* since this would have a major impact on the development of the mining sector (Fernihough and O'Rourke, 2021). We also control for the distance from the administrative center of each *département* to Paris, given its economic and political importance within France.

3 Empirical Strategy

There are three econometric issues in this study: omitted variables, measurement error and reverse causality.[8]

One or several omitted variables could be correlated with an area's education and potential economic development. However, in our study where we account for the characteristics of 89 administrative units (the *départements*), 394 high-schools and three sample years with fixed effects, the absence of an omitted variable bias implies two conditions which are plausibly satisfied. First, investment decisions in mines were not complementary to secondary school openings. Mines were indeed financed by private investors while high-schools were usually funded by the central and local governments as well as by the parents of high-school pupils. There is no evidence to suggest that private investors opened mines next to the high-school where their children (if they had any) studied. If anything, given the continued growth of the central administration in France during the 19th century France that was noted by thinkers as different as Marx (1852), Tocqueville (1856) and Taine (1893), it is unlikely that the empirical analysis could be affected by the correlation between local state capacity, private property rights and human capital formation. Namely, the ability of the French state to enforce property rights in various parts of the country was most likely not correlated with the number of mines in activity (which depended on the carboniferous

[8]These issues are related, although not entirely identical, to those of Atkin (2016) whose study can take advantage of cohort-year fixed effects while the data here only pertain to pupils and teachers in three years (1865, 1876, and 1887).

nature of the soil) and/or with the number of high-schools. Second, *départements* can be viewed as small open economies where the mining industry exported its production to other *départements* and other countries. It is therefore unlikely that local demand shocks would on their own affect decisions regarding high-school enrollment and the demand for local industrial output.

Measurement error could only be an issue if mining companies systematically misreported the horse power of steam engines and/or that this misreporting directly impacted school enrollment. First, it is unclear which production or fiscal objective such misreporting would serve. Second, it is unlikely to have occurred because mining companies could not operate without a governmental authorization and were under the local supervision of the engineers from the *Inspection Générale des Mines* which was an office in the Ministry of Public Works.

Reverse causality might be an issue as the presence of high-schools and the share of high-school pupils in the population or following a specific curriculum may potentially influence firm hiring decisions. This is unlikely because entrepreneurs seeking to open a mine could not simply undertake explorations to determine whether there was a sufficient quantity of minerals for operations to be profitable. To undertake such explorations, they would first have to request an authorization from the *Inspection Générale des Mines*. The legal procedure to obtain this authorization and the ensuing mining exploration usually took two years at least. They entailed substantial fixed costs and were unlikely to be driven by variations in the total number of pupils in nearby high schools or by the share of high-school pupils in specific sections. If anything, data on school enrollment were usually not readily available.

Nonetheless, to relieve concerns regarding our empirical approach, the identification strategy uses the number of mines in activity in each *département*. Its logic is that the opening and closing of mines, which were regulated by the *Inspection Générale des Mines* had a causal impact on the number of steam engines. The engineers within the *Inspection Générale des Mines* sought to maximize production and worker safety within the mineral industry (Chesneau, 1911). They were not involved in the management of high-schools, and more generally, did not have any prerogative within the education system. If anything, the exclusion restriction would not hold if the numbers of high-schools and high-school pupils were related to the availability of the local unskilled population but it is unlikely that these small numbers would entail systematic variations in the unskilled workforce.

The empirical specification can be presented in two stages and estimated with 2SLS. The second stage can be written as

$$Y_{it} = \alpha_i + \alpha_t + \beta_1 HP_{dt} + \beta_2 \boldsymbol{X'_d} + u_{it}, \tag{1}$$

where Y_{it} is one of our measures of human capital formation in high-school i in year t, HP_{dt} is the total horse power of steam engines employed in the mining industry in *département* d in year t, $\boldsymbol{X'_d}$

is a vector of economic characteristics of *département* d in year t that includes GDP per capita and the number of male Catholic clergymen. Equation 1 also includes department-level time invariant characteristics (i.e., distance to Paris and share of carboniferous area) which are interacted with time fixed effects to account for the possibility that these geographic characteristics might have a different impact over time. Finally, u_{it} is an i.i.d. error term for high-school i in year t while α_i and α_t are the high-school- and year-fixed effects.

In the first stage, HP_{dt} is instrumented by $Mines_{dt}$, which represents the number of active mines in *département* d in year t

$$HP_{dt} = \gamma_d + \gamma_t + \delta_1 Mines_{dt} + \delta_2 \boldsymbol{X'_d} + v_{dt}, \tag{2}$$

where $\boldsymbol{X'_d}$ is the same vector of geographical and economic characteristics of *département* d in year t used in Equation 1, γ_d and γ_t are *département*- and year-fixed effects while v_{dt} is an i.i.d. error term for *département* d in year t. In both Equations, standard errors are clustered at the high-school level.

It is worth noting that the identification strategy for industrial intensity in this study is different from that of Franck and Galor (2022). This is because Franck and Galor (2022) rely on time-invariant instrumental variables, i.e., the distance to Fresnes-sur-Escaut (the village in the North of France where the steam engine was first used for industrial purposes in a mine in 1732) and variations in wheat prices, to causally explain industrial capacity over the 1839-1847 period in a cross-section dataset. In this study however, Equations 1 and 2 include fixed effects which would fully capture the instruments of Franck and Galor (2022). Still, to ensure the consistency between this study and that of Franck and Galor (2022), Appendix Table B.2 shows that the distance to Fresnes and wheat prices are significantly and negatively correlated with the horse power of steam engines in the mining sector when Equation 2 is run separately for each year in the panel.

4 Results

Table 1 shows the first stage regression results relating mining activity to the horse power of steam engines while Tables 2-4 report the OLS, 2SLS and reduced form regressions for the effect of industrialization on high-school education in 1865, 1876 and 1887 (the complete specifications with the control variables are shown in the Appendix).

In the empirical analysis, the number of observations is that of the high-schools (both *collèges* and *lycées*) within the *départements*. As we noted above, some high-schools opened while other closed in the years of our sample so that the regressions often have more than 900 observations.

4.1 Active mines and the horse power of steam engines

Table 1 suggests that variations in the number of active mines increased the horse power of steam engines in each *département*. The coefficient associated with the number of active mines is positive and significant at the 1% level in all the specifications in Table 1 where we progressively add our control variables. In particular, in Column (3) of Table 1, a 1% increase in the number of mines in a *département* is associated with a 19.0% increase in the log of the horse power of steam engines in a *département*. As such, a *département* at the mean of the distribution of active mines (26.01) would experience a substantial increase of 494 horse power of steam engines in the mining industry (relative to a mean of 8696 and a standard deviation of 17,825).

Table 1: Mines and the Horse Power of Steam Engines in 19$^{\text{th}}$ Century France

	(1)	(2)	(3)
First Stage: Horse Power of Steam Engines			
Mines	0.115**	0.230***	0.190***
	[0.0511]	[0.0409]	[0.0338]
Geographic Controls*Year Fixed Effects	No	Yes	Yes
Male Catholic Clergy	No	Yes	Yes
GDP p.c.	No	No	Yes
Year- and High-School Fixed Effects	Yes	Yes	Yes
1st stage F-stat	5.054	31.755	31.429
Clusters	394	394	394
Observations	976	976	976

Note: This table presents first-stage regressions relating the number of mines to the horse power of steam engines in each *département* in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. Robust clustered standard errors at the high-school level 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 Industrialization and secondary schooling

Table 2 shows the impact of industrialization on high-school enrollment at the high-school level. As a robustness check, Table B.4 report the same regressions at the *département* level for the 85 *départements* which were always part of France during the sample period.

Columns (1)-(2) of Table 2 show that industrialization had a positive and significant effect on the share of high-school pupils in applied and scientific studies. In Column (2) of Table 2, a 1% increase in the log of steam engines in a *département* is associated with a 7.09% increase in the share of high-school pupils in the *enseignement special* out of the total number of high-school pupils. Furthermore, Columns (3)-(4) show that within the *enseignement classique*, industrialization increased the share of high-school pupils in the "mathematical section": the effect is significant at the 10% level in the OLS regression of Column (3) in Table B.4 and is borderline significant (p-value=0.109) in the 2SLS Regression in Column (4) of Table 2. Moreover, Columns (5)-(12) of

Table 2 show that industrialization had a negative but mostly insignificant effect on the share of high-school pupils out of the male *département* population age 15-18.

Table 2: 19th Century Industrialization and High-School Pupils

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section in *Enseignement Classique*		Share of High-School Pupils		Share of High-School Pupils in Enseignement Special out of Male Population Age 15-18 in Department		Share of High-School Pupils in Literary Section		Share of High-School Pupils in Math Section	
Steam Engines	0.0219***	0.0709**	0.0011	0.0324	-0.0025***	-0.0016	-0.0005***	-2.11e-06	-8.49e-05***	-0.0002	-0.0001*	-0.0001
	[0.0064]	[0.0281]	[0.0051]	[0.0203]	[0.0005]	[0.0027]	[0.0001]	[0.0007]	[2.79e-05]	[0.0002]	[6.68e-05]	[0.00062]
GDP p.c. and Geographic Controls*Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year- and High-School F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.252		0.053		0.114		0.185		0.260		0.058	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394
Observations	976	976	990	990	976	976	976	976	977	977	977	977
	First stage: the instrumented variable is Horse Power of Steam Engines											
Mines		0.190***		0.196***		0.190***		0.190***		0.191***		0.191***
		[0.0338]		[0.0337]		[0.0338]		[0.0338]		[0.0339]		[0.0339]
1st stage F-stat		31.429		33.842		31.429		31.429		31.855		31.855
	Reduced Form: the dependent variable is											
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section in *Enseignement Classique*		Share of High-School Pupils		Share of High-School Pupils in Enseignement Special out of Male Population Age 15-18		Share of High-School Pupils in Literary Section		Share of High-School Pupils in Math Section	
Mines		0.0134***		0.0064		-0.000301		-3.99e-07		-4.49e-05		-2.19e-05
		[0.005]		[0.004]		[0.0005]		[0.00013]		[3.77e-05]		[0.0001]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to high-school pupils in the various sections of secondary schooling in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

The shift caused by industrialization towards scientific studies is in line with the regressions in Panel A of Table 3 which show that high-schools offered a significantly higher wage to mathematics teachers but not to other teachers. Specifically, Column (1) in Panel A of Table 3 shows that a 1% increase in the log of steam engines in a *département* is associated with a 22.9% increase in the wage of mathematics teachers. On the one hand, it must be noted that the table of descriptive statistics in Appendix Table A.1 shows that the wages of mathematics teachers were lower on average than those of other subjects. It is therefore possible that this difference in salaries can be attributed to seniority by subject, the relative supply of teachers by subject, or that mathematics teachers had better outside options and could easily complement their relatively low wages. On the other hand, the positive and significant effect of industrialization on the wages of mathematics teachers is in line with the notion that mathematics would be more valued in schools with a slightly more applied curriculum (where Greek and Latin studies would be neglected) and where most high-school pupils would expect to later work in the industrial sector.[9]

Furthermore, the 2SLS regression in Panel B of Table 3 shows that industrialization had a positive and significant impact at the 10% level on the number of teachers in the *enseignement*

[9]We can exclude the possibility that the increase in wages is associated with the mining areas where politicians assigned more importance to scientific teaching because wages were ultimately left to the discretion of high-school principals.

Table 3: 19th Century Industrialization and High-School Teachers

Panel A. Wages of Teachers

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV
	Wage of Math Teacher		Wage of Physics Teacher		Wage of History Teacher		Wage of Philosophy Teacher		Wage of Rhetoric Teacher	
Steam Engines	0.229*	1.036**	0.0515	0.263	-0.191	0.714	-0.166	0.0747	-0.276*	0.0915
	[0.134]	[0.482]	[0.145]	[0.534]	[0.132]	[0.501]	[0.151]	[0.448]	[0.150]	[0.439]
GDP p.c. and Geographic Controls*Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year- and High-School F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.015		0.038		0.033		0.026		0.029	
Clusters	394	394	394	394	394	394	394	394	394	394
Observations	469	469	469	469	469	469	469	469	469	469
	First stage: the instrumented variable is Number of Steam Engines									
Mines		0.283***		0.283***		0.283***		0.283***		0.283***
		[0.0485]		[0.0485]		[0.0485]		[0.0485]		[0.0485]
1st stage F-stat		33.966		33.966		33.966		33.966		33.966
	Reduced Form: the dependent variable is Wage of									
	Math Teacher		Physics Teacher		History Teacher		Philosophy Teacher		Rhetoric Teacher	
Mines		0.293**	0.283***	0.0745	0.283***	0.202	0.283***	0.0211	0.283***	0.0259
		[0.132]	[0.0485]	[0.152]	[0.0485]	[0.135]	[0.0485]	[0.128]	[0.0485]	[0.125]

Panel B. Numbers of Teachers

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV
	Number of Teachers in Enseignement Special		Enseignement Classique		Science		Philosophy in Enseignement Classique		History in Enseignement Classique		Foreign Languages	
Steam Engines	0.0103	0.130*	-0.0136	-0.107	0.0107	-0.0446	-0.0104	-0.0408	-0.0120	0.0227	-0.0025	-0.0094
	[0.0163]	[0.0780]	[0.0278]	[0.110]	[0.0216]	[0.0780]	[0.0147]	[0.0620]	[0.0141]	[0.0550]	[0.0174]	[0.0680]
GDP p.c. and Geographic Controls*Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year- and High-School F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.101		0.018		0.048		0.027		0.079		0.196	
Clusters	283	283	283	283	283	283	283	283	283	283	283	283
Observations	703	703	703	703	703	703	703	703	703	703	703	703
	First stage: the instrumented variable is Horse Power of Steam Engines											
Mines		0.198***		0.198***		0.198***		0.198***		0.198***		0.198***
		[0.0362]		[0.0362]		[0.0362]		[0.0362]		[0.0362]		[0.0362]
1st stage F-stat		29.913		29.913		29.913		29.913		29.913		29.913
	Reduced Form: the dependent variable is Number of Professors in											
	Enseignement Special		Enseignement Classique		Science		Philosophy in Enseignement Classique		History in Enseignement Classique		Foreign Languages	
Mines		0.0258*		-0.0212		-0.0088		-0.0081		0.0045		-0.0019
		[0.0153]		[0.0211]		[0.0151]		[0.0121]		[0.0110]		[0.0135]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to the wage of high-school teachers by subject in 1865 and 1876 and to their number in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

spécial, in line with the rise in the share of high-school pupils in the *enseignement spécial* which we noted above in Table 2. However, industrialization did not significantly increase the number of high-school teachers in any other subject. This is most likely because the number of high-school teachers was not determined by supply and demand. Instead it was set by the civil servants in the Ministry of Education while high-school teachers were selected through competitive and challenging exams.

Table 4: 19th Century Industrialization and Public Spending on Secondary Schooling

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV	(13) OLS	(14) IV
	Subventions to High-Schools from the						High-School Total				Share of Pupils with Central State		Share of Pupils with	
	Central State		Departments		Communes		Expenses		Revenues		Scholarships out of Total High-School Pupils			
Steam Engines	-0.309***	-1.197***	-0.0334	0.212	0.331**	0.928	-0.0410	-0.105	-0.0375	-0.113	-0.0001	-0.0118**	-0.0020	-0.0210**
	[0.119]	[0.422]	[0.0774]	[0.393]	[0.145]	[0.644]	[0.0367]	[0.164]	[0.0359]	[0.165]	[0.0008]	[0.0049]	[0.0015]	[0.0104]
GDP p.c. Male Clergy and Geographic Controls*Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year- and High-School F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.335		0.007		0.031		0.169		0.158		0.246		0.326	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394	394	394
Observations	946	946	934	934	959	959	948	948	948	948	976	976	976	976
	First stage: the instrumented variable is Horse Power of Steam Engines													
Mines		0.192***		0.188***		0.193***		0.191***		0.191***		0.190***		0.190***
		[0.0340]		[0.0347]		[0.0341]		[0.0340]		[0.0340]		[0.0338]		[0.0338]
1st stage F-stat		31.991		29.287		31.896		31.589		31.589		31.429		31.429
	Reduced Form: the dependent variable is													
	Subventions to High-Schools from the						High-School Total				Share of Pupils with Central State		Share of Pupils with	
	Central State		Departments		Communes		Expenses		Revenues		Scholarships out of Total High-School Pupils			
Mines		-0.230***		0.0397		0.179		-0.0201		-0.0216		-0.00224***		-0.00399**
		[0.0713]		[0.0726]		[0.122]		[0.0311]		[0.0311]		[0.000809]		[0.00183]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to public spending on secondary schooling in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Finally, Columns (1)-(2) of Table 4 show that the French central state geared high-school spending toward areas which were not industrialized while Columns (3)-(6) show no robust effect of industrialization on spending from the local governments.[10] In particular, Column (1) of Table 4 indicates that a 1% increase in the log of steam engines in a *département* is associated with a 30.9% decrease in the central state's subventions to high-schools. However, Columns (7)-(10) of Table 4 show that industrialization did not affect high-school spending and receipts in industrialized areas as the tuition fees paid by parents presumably compensated for the difference. Nonetheless, less financial support from the central state implied that pupils in industrialized areas were less likely to receive scholarships as shown in Columns (11)-(14) of Table 4.

[10] Appendix Tables B.8 and B.9 show that the significant results in Table 4 remain robust when the data are normalized by the male population age 15-18 or only by the total number of high-school pupils.

5 Conclusion

This paper assesses the impact of industrialization on secondary schooling in the 19^{th} century. Using French data in 1865, 1876 and 1887, the results suggest that industrialization had a negative but mainly insignificant effect on high-school enrollment. However, industrialization increased the share of high-school pupils in applied sections and the wages of high-school mathematics teachers.

Overall, the analysis suggests that industrialization changed the incentives for human capital formation of high-school pupils, who were mostly the children of families at the top of the social distribution at the time. Industry potentially offered high future earnings to engineers and thereby increased the appeal of applied scientific studies. Given the limited number of high-school pupils at the time, this increase in the share of high-school pupils in the applied sections came at the expense of the literary sections. In other words, the results suggest that industrialization during the industrial revolution did not only involve a quality-quantity trade-off which increased the demand for basic literacy skills as previous studies have shown (e.g., Atack et al., 2019, Franck and Galor, 2022), but that it also entailed a change in the qualitative formation of human capital, from humanities to science.

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Online Appendix

Table A.1: Descriptive Statistics

	Obs	Mean	Std Dev	Min	Max
Industrialization					
Horse Power of Steam Engines	990	8724	17894	0	105710
Geographic Variables & GDP per Capita					
Distance to Paris	990	338.52	179.11	1	687.37
GDP per Capita	990	0.59	0.27	0.25	2.02
Male Catholic Clergy	990	722.39	403.26	115	3007
Share of Carboniferous Area	990	486.17	809.13	0	3970.59
Number of Teachers					
Number of Teachers in Enseignement Special	703	2.32	1.58	0	14
Number of Teachers in Enseignement Classique	703	1.66	1.23	0	14
Number of Teachers of Science in Enseignement Classique	703	0.45	0.50	0	2
Number of Teachers of Philosophy in Enseignement Classique	703	0.34	0.49	0	3
Number of Teachers of History in Enseignement Classique	703	1.86	1.17	0	19
Number of Teachers of Foregin Languages in Enseignement Classique	703	0.82	0.83	0	6
High-School Pupils					
Share of High-School Pupils in Enseignement Special out of Total High-School Pupils	977	0.56	0.33	0.00	0.99
Share of High-School Pupils in Math Section Out of High-School Pupils in Enseignement Classique	703	3.53	4.06	0.04	23
Share of High-School Pupils in Enseignement Special out of Male Population Age 15-18	976	0.01	0.01	0.00	0.10
Share of High-School Pupils in Literary Section out of Male Population Age 15-18	976	0.00	0.00	0.00	0.01
Share of High-School Pupils out of Male Population Age 15-18	976	0.02	0.02	0.00	0.24
Share of High-School Pupils in Math Section out of Male Population Age 15-18	977	0.00	0.00	0.00	0.03
Share of High-School Pupils in Math Section out of Total High-School Pupils	990	0.25	0.20	0.00	0.50
Number of High-School Pupils	976	226.27	210.55	0.00	1596
High-School Finance and Teachers' Wages					
High-School Total Spending	948	120819	316615.3	140.9	8513096
High-School Total Receipts	948	132120.6	377279.8	3477	9397371
Subventions to High-Schools from the Central State	946	24364.94	52943.44	0	870000
Subventions to High-Schools from the Departments	934	626.75	4565.10	0	83575
Subventions to High-Schools from Communes	959	8840.53	9692.29	0	80620
Central State Scholarships out of Total High-School Pupils	976	0.03	0.04	0	0.25
Scholarships out of Total High-School Pupils	976	0.07	0.09	0	0.69
Wage of Math Teacher	469	406.38	768.81	0	4500
Wage of Physics Teacher	469	744.07	953.56	0	4500
Wage of History Teacher	469	437.04	827.34	0	3500
Wage of Philosophy Teacher	469	609.91	1139.51	0	16000
Wage of Rhetoric Teacher	469	549.80	884.07	0	4500

Note: The unit of observation is the high-school.

Full Regression Tables

Table B.1: Mines and the Horse Power of Steam Engines in 19$^{\text{th}}$ Century France

	(1)	(2)	(3)
First Stage: Horse Power of Steam Engines			
Mines	0.115**	0.230***	0.190***
	[0.0511]	[0.0409]	[0.0338]
Share of Carboniferous Area * Year Fixed Effects		-0.0000005	0.00005***
		[0.00001]	[0.00001]
Male Catholic Clergy		1.218***	0.900***
		[0.147]	[0.124]
Distance to Paris * Year Fixed Effects		-0.0004***	-0.0002***
		[0.00004]	[0.00004]
GDP per capita			2.232***
			[0.196]
Year- and High-School Fixed Effects	Yes	Yes	Yes
1st stage F-stat	5.054	31.755	31.429
Clusters	394	394	394
Observations	976	976	976

Note: This table presents first-stage regressions relating the number of mines to the horse power of steam engines in each *département* in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. Robust clustered standard errors at the high-school level 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: Mines and the Horse Power of Steam Engines in 19th Century France: Year-by-Year Analysis

	(1)	(2)	(3)
	First Stage: Horse Power of Steam Engines		
	1865	1876	1887
Wheat Price	-3.314***	-1.734*	-4.867***
	[1.040]	[0.910]	[0.854]
Distance from Fresnes sur Escaut	-0.000630***	-0.000703***	-0.000351***
	[3.86e-05]	[2.66e-05]	[3.08e-05]
GDP per capita	2.515***	2.285***	2.268***
	[0.282]	[0.225]	[0.148]
Share of Carboniferous Area * Year Fixed Effects	4.57e-05***	6.69e-05***	3.58e-05***
	[1.34e-05]	[1.02e-05]	[7.07e-06]
Male Catholic Clergy	1.381***	0.466***	0.305***
	[0.190]	[0.152]	[0.104]
Distance to Paris * Year Fixed Effects	0.000169***	0.000105***	5.69e-05***
	[3.25e-05]	[3.74e-05]	[1.67e-05]
Constant	13.19***	17.29***	25.12***
	[2.433]	[2.862]	[2.382]
1st stage F-stat	169.085	521.371	290.046
Observations	315	321	340
Year- and High-School Fixed Effects	Yes	Yes	Yes

Note: This table presents first-stage regressions relating the number of mines to the horse power of steam engines in each *département* separately for each year (1865, 1876 and 1887) in our sample. The relationship accounts for GDP per capita and the number of male Catholic clergymen and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. Robust clustered standard errors at the high-school level 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: 19th Century Industrialization and High-School Pupils

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section Out of High School Pupils in *Enseignement Classique*		Share of High-School Pupils		Enseignement Special out of Male Population Age 15-18 in Department		Share of High-School Pupils in Literary Section		Math Section	
Steam Engines	0.0219***	0.0709**	0.00107	0.0324	-0.00251***	-0.00159	-0.000530***	-2.11e-06	-8.49e-05***	-0.000235	-0.000112*	-0.000115
	[0.00642]	[0.0281]	[0.00506]	[0.0203]	[0.000486]	[0.00272]	[0.000140]	[0.000684]	[2.79e-05]	[0.000198]	[6.68e-05]	[0.000619]
Distance to Paris * Year Fixed Effects	1.53e-05***	2.10e-05***	-5.84e-06	-2.06e-06	8.83e-07	9.89e-07	3.21e-07**	3.83e-07**	2.08e-08	3.02e-09	5.64e-08	5.61e-08
	[5.42e-06]	[6.25e-06]	[3.90e-06]	[4.60e-06]	[5.53e-07]	[6.32e-07]	[1.41e-07]	[1.50e-07]	[3.16e-08]	[4.33e-08]	[8.85e-08]	[1.25e-07]
Share of Carboniferous Area * Year Fixed Effects	-4.24e-06**	-6.77e-06***	-3.47e-06***	-5.10e-06***	-2.99e-07*	-3.46e-07	-1.64e-07***	-1.91e-07***	-1.22e-08	-4.50e-09	-3.48e-08	-3.47e-08
	[1.68e-06]	[2.33e-06]	[1.31e-06]	[1.70e-06]	[1.69e-07]	[2.23e-07]	[4.20e-08]	[5.22e-08]	[9.50e-09]	[1.39e-08]	[2.78e-08]	[5.05e-08]
Male Catholic Clergy	-0.0590***	-0.106***	0.0241	-0.00419	-0.00381**	-0.00469	-0.00185***	-0.00235***	-0.000116	2.36e-05	0.000124	0.000126
	[0.0196]	[0.0360]	[0.0161]	[0.0252]	[0.00165]	[0.00310]	[0.000411]	[0.000872]	[9.86e-05]	[0.000211]	[0.000222]	[0.000568]
GDP per capita	-0.131***	-0.244***	-0.0402	-0.112**	0.00837**	0.00626	0.000219	-0.000995	0.000159	0.000505	0.000640	0.000647
	[0.0387]	[0.0704]	[0.0280]	[0.0521]	[0.00407]	[0.00759]	[0.00104]	[0.00192]	[0.000226]	[0.000492]	[0.000570]	[0.00155]
Constant	0.448***	0.319*	0.0606	-0.0342	0.0577***	0.0553***	0.0187***	0.0173***	0.00133*	0.00176*	0.000708	0.000715
	[0.153]	[0.170]	[0.122]	[0.129]	[0.0133]	[0.0149]	[0.00335]	[0.00331]	[0.000769]	[0.000984]	[0.00188]	[0.00284]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.252		0.053		0.114		0.185		0.260		0.058	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394
Observations	976	976	990	990	976	976	976	976	977	977	977	977
	First stage: the instrumented variable is Horse Power of Steam Engines											
Mines		0.190***		0.196***		0.190***		0.190***		0.191***		0.191***
		[0.0338]		[0.0337]		[0.0338]		[0.0338]		[0.0339]		[0.0339]
1st stage F-stat		31.429		33.842		31.429		31.429		31.855		31.855
	Reduced Form: the dependent variable is											
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section Out of High School Pupils in *Enseignement Classique*		Share of High-School Pupils		Enseignement Special out of Male Population Age 15-18		Share of High-School Pupils in Literary Section		Math Section	
Mines		0.0134***		0.00635		-0.000301		-3.99e-07		-4.49e-05		-2.19e-05
		[0.00498]		[0.00400]		[0.000524]		[0.000130]		[3.77e-05]		[0.000119]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to high-school pupils in the various sections of secondary schooling in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.4: 19^{th} Century Industrialization and High-School Pupils: Department-Level Regressions

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section Out of High School Pupils in *Enseignement Classique*		Share of High-School Pupils		Share of Enseignement Special out of Male Population Age 15-18		Share of High-School Pupils in Literary Section		Share of High-School Pupils in Math Section	
Steam Engines	0.0902**	0.236	0.0320*	0.187	-0.00314*	0.00436	3.77e-05	0.00349	-0.000191**	-0.00116	-0.000204	0.000256
	[0.0383]	[0.169]	[0.0179]	[0.116]	[0.00163]	[0.0132]	[0.000658]	[0.00452]	[9.24e-05]	[0.00127]	[0.000256]	[0.00336]
Distance to Paris * Year Fixed Effects	4.54e-05	7.89e-05*	-1.68e-05	1.86e-05	4.57e-06*	6.29e-06	2.14e-06***	2.93e-06**	8.16e-08	-1.41e-07	1.40e-07	2.46e-07
	[3.04e-05]	[4.77e-05]	[1.68e-05]	[3.69e-05]	[2.57e-06]	[4.34e-06]	[7.21e-07]	[1.42e-06]	[1.62e-07]	[3.15e-07]	[4.04e-07]	[9.41e-07]
Share of Carboniferous Area * Year Fixed Effects	-8.97e-06	-1.38e-05	-5.03e-06	-1.01e-05	-6.13e-07	-8.60e-07	-5.09e-07**	-6.22e-07**	-2.01e-08	1.18e-08	-7.00e-08	-8.51e-08
	[8.29e-06]	[9.93e-06]	[5.00e-06]	[6.71e-06]	[6.53e-07]	[8.70e-07]	[2.23e-07]	[3.04e-07]	[3.70e-08]	[6.29e-08]	[9.04e-08]	[1.74e-07]
Male Catholic Clergy	-0.0243	-0.155	0.159***	0.0215	-0.00305	-0.00973	-0.00431**	-0.00739	0.000279	0.00114	0.00178**	0.00137
	[0.0864]	[0.191]	[0.0462]	[0.120]	[0.00573]	[0.0135]	[0.00201]	[0.00506]	[0.000381]	[0.00117]	[0.000817]	[0.00279]
GDP per capita	-0.125	-0.450	0.0495	-0.294	0.0574***	0.0407	0.00786	0.000177	0.00221**	0.00437	0.00506***	0.00403
	[0.197]	[0.402]	[0.126]	[0.290]	[0.0186]	[0.0348]	[0.00531]	[0.0117]	[0.00101]	[0.00309]	[0.00163]	[0.00762]
Year- and Department-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.178		0.260		0.321		0.226		0.577		0.341	
Clusters	85	85	85	85	85	85	85	85	85	85	85	85
Observations	255	255	255	255	255	255	255	255	255	255	255	255
	First stage: the instrumented variable is Horse Power of Steam Engines											
Mines		0.136**		0.136**		0.136**		0.136**		0.136**		0.136**
		[0.0661]		[0.0661]		[0.0661]		[0.0661]		[0.0661]		[0.0661]
1st stage F-stat		4.245		4.245		4.245		4.245		4.245		4.245
	Reduced Form: the dependent variable is											
	Share of High-School Pupils in *Enseignement Spécial* out of Total High-School Pupils		Share of High-School Pupils in Math Section Out of High School Pupils in *Enseignement Classique*		Share of High-School Pupils		Share of Enseignement Special out of Male Population Age 15-18		Share of High-School Pupils in Literary Section		Share of High-School Pupils in Math Section	
Mines		0.0322		0.0254		0.000593		0.000475		-0.000158		3.49e-05
		[0.0215]		[0.0155]		[0.00178]		[0.000550]		[0.000155]		[0.000470]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to high-school pupils in the various sections of secondary schooling in 1865, 1876 and 1887 at the department-level. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.5: 19^{th} Century Industrialization and High-School Pupils and the Wage of High-School Teachers by Subject

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV
	Wage of									
	Math Teacher		Physics Teacher		History Teacher		Philosophy Teacher		Rhetoric Teacher	
Steam Engines	0.229*	1.036**	0.0515	0.263	-0.191	0.714	-0.166	0.0747	-0.276*	0.0915
	[0.134]	[0.482]	[0.145]	[0.534]	[0.132]	[0.501]	[0.151]	[0.448]	[0.150]	[0.439]
Distance to Paris * Year Fixed Effects	-8.88e-05	0.000203	7.01e-06	8.36e-05	-6.24e-05	0.000265	6.60e-05	0.000153	-7.28e-05	6.02e-05
	[0.000185]	[0.000269]	[0.000188]	[0.000270]	[0.000180]	[0.000269]	[0.000174]	[0.000234]	[0.000176]	[0.000237]
Share of Carboniferous Area * Year Fixed Effects	-4.12e-05	-0.000116**	4.78e-06	-1.48e-05	-8.10e-06	-9.18e-05*	-7.71e-05*	-9.94e-05*	-5.73e-05	-9.13e-05
	[3.71e-05]	[5.29e-05]	[4.18e-05]	[6.22e-05]	[3.58e-05]	[5.52e-05]	[4.21e-05]	[5.56e-05]	[4.21e-05]	[5.58e-05]
Male Catholic Clergy	0.136	-0.993	0.00377	-0.293	0.143	-1.123	1.245**	0.908	1.504***	0.990
	[0.392]	[0.753]	[0.516]	[0.881]	[0.408]	[0.833]	[0.483]	[0.752]	[0.467]	[0.712]
GDP per capita	-0.647	-3.295*	0.927	0.232	1.570*	-1.399	0.361	-0.430	-0.0269	-1.233
	[0.920]	[1.686]	[0.923]	[1.876]	[0.802]	[1.760]	[0.928]	[1.588]	[0.925]	[1.577]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.015		0.038		0.033		0.026		0.029	
Clusters	394	394	394	394	394	394	394	394	394	394
Observations	469	469	469	469	469	469	469	469	469	469
	First stage: the instrumented variable is Number of Steam Engines									
Mines		0.283***		0.283***		0.283***		0.283***		0.283***
		[0.0485]		[0.0485]		[0.0485]		[0.0485]		[0.0485]
1st stage F-stat		33.966		33.966		33.966		33.966		33.966
	Reduced Form: the dependent variable is Wage of									
	Math Teacher		Physics Teacher		History Teacher		Philosophy Teacher		Rhetoric Teacher	
Mines		0.293**		0.0745		0.202		0.0211		0.0259
		[0.132]		[0.152]		[0.135]		[0.128]		[0.125]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to the wage of high-school teachers by subject in 1865 and 1876. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.6: 19^{th} Century Industrialization and High-School Pupils and the Number of High-School Teachers by Subject

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV
	Number of Teachers in											
	Enseignement Special		Enseignement Classique		Science		Philosophy		History		Foreign Languages	
	in Enseignement Classique											
Steam Engines	0.0103	0.130*	-0.0136	-0.107	0.0107	-0.0446	-0.0104	-0.0408	-0.0120	0.0227	-0.00254	-0.00940
	[0.0163]	[0.0780]	[0.0278]	[0.110]	[0.0216]	[0.0780]	[0.0147]	[0.0620]	[0.0141]	[0.0550]	[0.0174]	[0.0680]
Distance to Paris * Year Fixed Effects	1.65e-05	5.65e-05	-2.12e-05	-5.25e-05	-1.51e-05	-3.35e-05	-1.21e-06	-1.13e-05	-1.38e-05	-2.18e-06	-1.16e-05	-1.39e-05
	[2.19e-05]	[3.68e-05]	[3.44e-05]	[4.58e-05]	[2.97e-05]	[3.35e-05]	[1.51e-05]	[2.51e-05]	[1.99e-05]	[2.66e-05]	[2.29e-05]	[2.94e-05]
Share of Carboniferous Area * Year Fixed Effects	-7.10e-06*	-1.67e-05**	-9.66e-06	-2.16e-06	-4.06e-06	3.67e-07	-7.79e-06**	-5.36e-06	-1.12e-06	-3.90e-06	-5.59e-06	-5.04e-06
	[3.91e-06]	[7.49e-06]	[7.70e-06]	[1.17e-05]	[5.50e-06]	[7.69e-06]	[3.79e-06]	[6.15e-06]	[3.49e-06]	[5.55e-06]	[4.19e-06]	[6.67e-06]
Male Catholic Clergy	0.0451	-0.101	0.116	0.230	0.0228	0.0901	0.0638	0.101	0.0125	-0.0298	0.0415	0.0498
	[0.0462]	[0.108]	[0.0832]	[0.159]	[0.0643]	[0.115]	[0.0425]	[0.0854]	[0.0379]	[0.0740]	[0.0492]	[0.0870]
GDP per capita	-0.00105	-0.354	0.0185	0.294	0.0565	0.219	-0.0848	0.00440	0.103	0.000604	0.132	0.152
	[0.0988]	[0.235]	[0.156]	[0.344]	[0.119]	[0.241]	[0.0809]	[0.195]	[0.0811]	[0.175]	[0.0938]	[0.214]
Constant	0.398	-0.0230	1.581***	1.910***	0.800*	0.994**	-0.0950	0.0112	0.355	0.233	0.241	0.265
	[0.394]	[0.488]	[0.605]	[0.675]	[0.483]	[0.501]	[0.303]	[0.369]	[0.309]	[0.356]	[0.360]	[0.437]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.101		0.018		0.048		0.027		0.079		0.196	
Clusters	283	283	283	283	283	283	283	283	283	283	283	283
Observations	703	703	703	703	703	703	703	703	703	703	703	703
	First stage: the instrumented variable is Horse Power of Steam Engines											
Mines		0.198***		0.198***		0.198***		0.198***		0.198***		0.198***
		[0.0362]		[0.0362]		[0.0362]		[0.0362]		[0.0362]		[0.0362]
1st stage F-stat		29.913		29.913		29.913		29.913		29.913		29.913
	Reduced Form: the dependent variable is Number of Professors in											
	Enseignement Special		Enseignement Classique		Science		Philosophy		History		Foreign Languages	
	in Enseignement Classique											
Mines		0.0258*		-0.0212		-0.00884		-0.00808		0.00450		-0.00186
		[0.0153]		[0.0211]		[0.0151]		[0.0121]		[0.0110]		[0.0135]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to the number of high-school teachers by subject in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.7: 19^{th} Century Industrialization and Public Spending on Secondary Schooling

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV	(13) OLS	(14) IV
	Subventions to High-Schools from the						High-School Total				Share of Pupils with Central State Scholarships		Share of Pupils with Scholarships	
	Central State		Departments		Communes		Expenses		Revenues		out of Total High-School Pupils			
Steam Engines	-0.309***	-1.197***	-0.0334	0.212	0.331**	0.928	-0.0410	-0.105	-0.0375	-0.113	-0.000120	-0.0118**	-0.00204	-0.0210**
	[0.119]	[0.422]	[0.0774]	[0.393]	[0.145]	[0.644]	[0.0367]	[0.164]	[0.0359]	[0.165]	[0.000837]	[0.00485]	[0.00154]	[0.0104]
Distance to Paris * Year Fixed Effects	-5.74e-05	-0.000148	5.27e-05	7.72e-05	0.000259*	0.000327**	-0.000127***	-0.000134***	-0.000128***	-0.000136***	-2.50e-06***	-3.85e-06***	-2.20e-06	-4.40e-06**
	[8.87e-05]	[0.000105]	[5.84e-05]	[7.21e-05]	[0.000136]	[0.000149]	[3.74e-05]	[3.94e-05]	[3.72e-05]	[3.92e-05]	[8.64e-07]	[1.16e-06]	[1.50e-06]	[2.02e-06]
Share of Carboniferous Area * Year Fixed Effects	-8.50e-07	4.84e-05	-1.20e-06	-1.46e-05	-4.95e-05	-8.15e-05	9.13e-06	1.27e-05	5.83e-06	1.00e-05	-2.10e-07	3.95e-07	-4.53e-07	5.29e-07
	[2.56e-05]	[3.47e-05]	[2.53e-05]	[3.30e-05]	[4.46e-05]	[5.51e-05]	[1.12e-05]	[1.44e-05]	[1.10e-05]	[1.44e-05]	[2.33e-07]	[3.87e-07]	[4.52e-07]	[7.67e-07]
Male Catholic Clergy	-0.0401	0.832	0.210	-0.0314	-0.758	-1.332*	0.264**	0.327	0.239**	0.313	-0.000324	0.0109*	0.00438	0.0226*
	[0.299]	[0.540]	[0.303]	[0.488]	[0.482]	[0.760]	[0.118]	[0.199]	[0.118]	[0.199]	[0.00287]	[0.00568]	[0.00594]	[0.0121]
GDP per capita	-0.739	1.498	-0.363	-0.969	-1.707*	-3.158*	0.670**	0.829*	0.600**	0.788	-0.0152***	0.0117	-0.0289***	0.0148
	[0.512]	[1.145]	[0.475]	[1.053]	[0.915]	[1.813]	[0.265]	[0.488]	[0.265]	[0.492]	[0.00443]	[0.0118]	[0.00861]	[0.0252]
Constant	6.643***	8.825***	-1.161	-1.745	5.912	4.322	10.92***	11.08***	11.14***	11.33***	0.0323	0.0631**	0.0139	0.0638
	[2.425]	[2.675]	[2.228]	[2.432]	[3.733]	[4.196]	[0.936]	[1.004]	[0.928]	[1.002]	[0.0232]	[0.0287]	[0.0451]	[0.0537]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.335		0.007		0.031		0.169		0.158		0.246		0.326	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394	394	394
Observations	946	946	934	934	959	959	948	948	948	948	976	976	976	976
	First stage: the instrumented variable is Horse Power of Steam Engines													
Mines		0.192***		0.188***		0.193***		0.191***		0.191***		0.190***		0.190***
		[0.0340]		[0.0347]		[0.0341]		[0.0340]		[0.0340]		[0.0338]		[0.0338]
1st stage F-stat		31.991		29.287		31.896		31.589		31.589		31.429		31.429
	Reduced Form: the dependent variable is													
	Subventions to High-Schools from the						High-School Total				Share of Pupils with Central State Scholarships		Share of Pupils with Scholarships	
	Central State		Departments		Communes		Expenses		Revenues		out of Total High-School Pupils			
Mines		-0.230***		0.0397		0.179		-0.0201		-0.0216		-0.00224***		-0.00399**
		[0.0713]		[0.0726]		[0.122]		[0.0311]		[0.0311]		[0.000809]		[0.00183]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to public spending on secondary schooling in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.8: 19^{th} Century Industrialization and Public Spending on Secondary Schooling out of the Male Population Age 15-18

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV	(13) OLS	(14) IV
	Subventions to High-Schools						High-School		High-School		Central State Scholarships		All Scholarships	
	from the Central State		from the Departements		from the Communes		Total Spending		Total Receipts					
	out of the Male Population Age 15-18						out of the Male Population Age 15-18				out of the Male Population Age 15-18			
Steam Engines	-0.114***	-0.345***	-0.00291	0.0189	-0.0258*	0.114	-0.142***	-0.216	-0.139***	-0.222	-3.87e-05	-0.000180	-0.000138**	-0.000582
	[0.0287]	[0.118]	[0.00454]	[0.0228]	[0.0147]	[0.0790]	[0.0298]	[0.136]	[0.0297]	[0.139]	[3.08e-05]	[0.000205]	[6.75e-05]	[0.000400]
annee==1876	0.0437	0.336**	0.00625	-0.0224	0.127***	-0.0521	0.256***	0.350*	0.236***	0.340*	0.000138*	0.000316	0.000624***	0.00118**
	[0.0757]	[0.162]	[0.0207]	[0.0307]	[0.0381]	[0.107]	[0.0700]	[0.180]	[0.0704]	[0.182]	[7.67e-05]	[0.000266]	[0.000202]	[0.000574]
annee==1887	0.671***	1.158***	-0.000207	-0.0464	0.185***	-0.113	0.632***	0.789***	0.599***	0.774***	0.000823***	0.00112***	0.00213***	0.00307***
	[0.0882]	[0.257]	[0.0212]	[0.0507]	[0.0472]	[0.175]	[0.0902]	[0.293]	[0.0895]	[0.300]	[0.000108]	[0.000418]	[0.000231]	[0.000883]
Distance to Paris * Year Fixed Effects	-1.95e-05	-4.30e-05*	1.58e-06	3.77e-06	1.39e-05	2.98e-05*	-4.45e-05	-5.24e-05	-4.64e-05	-5.53e-05	-2.58e-08	-4.21e-08	3.47e-08	-1.67e-08
	[2.09e-05]	[2.49e-05]	[2.37e-06]	[2.97e-06]	[1.23e-05]	[1.60e-05]	[3.15e-05]	[3.35e-05]	[3.17e-05]	[3.37e-05]	[3.29e-08]	[4.59e-08]	[6.73e-08]	[8.20e-08]
Share of Carboniferous Area * Year Fixed Effects	-4.82e-06	7.98e-06	-7.17e-07	-1.91e-06	-1.56e-05***	-2.31e-05***	-1.79e-05*	-1.38e-05	-2.05e-05**	-1.59e-05	-2.28e-08**	-1.54e-08	-5.10e-08**	-2.81e-08
	[7.37e-06]	[9.60e-06]	[1.35e-06]	[1.48e-06]	[4.58e-06]	[6.14e-06]	[9.34e-06]	[1.19e-05]	[9.38e-06]	[1.21e-05]	[1.09e-08]	[1.62e-08]	[2.14e-08]	[2.93e-08]
Male Catholic Clergy	-0.0933	0.133	-0.00219	-0.0237	-0.134***	-0.268***	-0.127	-0.0547	-0.148	-0.0677	-0.000217*	-8.18e-05	-0.000465**	-3.99e-05
	[0.0789]	[0.144]	[0.0236]	[0.0335]	[0.0483]	[0.0942]	[0.0965]	[0.161]	[0.0976]	[0.163]	[0.000111]	[0.000212]	[0.000231]	[0.000483]
GDP per capita	-0.146	0.435	0.00302	-0.0509	-0.140	-0.480**	0.412*	0.596	0.355	0.561	-0.000224	0.000101	-0.000288	0.000733
	[0.140]	[0.322]	[0.0200]	[0.0582]	[0.0899]	[0.215]	[0.227]	[0.414]	[0.230]	[0.422]	[0.000199]	[0.000501]	[0.000385]	[0.000973]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.147		-0.005		0.111		0.132		0.127		0.118		0.157	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394	394	394
Observations	946	946	934	934	959	959	948	948	948	948	976	976	976	976
	First stage: the instrumented variable is Horse Power of Steam Engines													
Mines		0.192***		0.188***		0.193***		0.191***		0.191***		0.190***		0.190***
		[0.0340]		[0.0347]		[0.0341]		[0.0340]		[0.0340]		[0.0338]		[0.0338]
1st stage F-stat		31.991		29.287		31.896		31.589		31.589		31.429		31.429
	Reduced Form: the dependent variable is													
	Subventions to High-Schools						High-School		High-School		Central State Scholarships		All Scholarships	
	from the Central State		from the Departements		from the Communes		Total Spending		Total Receipts					
	out of the Male Population Age 15-18						out of the Male Population Age 15-18				out of the Male Population Age 15-18			
Mines		-0.0663***		0.00355		0.0220		-0.0413		-0.0425		-3.41e-05		-0.000110
		[0.0213]		[0.00418]		[0.0140]		[0.0265]		[0.0268]		[3.85e-05]		[7.47e-05]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to public spending on secondary schooling out of the male population age 15-18 in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.

Table B.9: 19^{th} Century Industrialization and Public Spending on Secondary Schooling per High-School Pupil

	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV	(9) OLS	(10) IV	(11) OLS	(12) IV	(13) OLS	(14) IV
	Subventions to High-Schools						High-School		High-School		Central State Scholarships		All Scholarships	
	from the Central State		from the Departements		from the Communes		Total Spending per High-School Pupil		Total Receipts					
Steam Engines	-0.178***	-0.722***	-2.59e-05	0.150	0.159**	0.518	-0.0109	-0.00409	-0.00717	-0.0113	-0.000120	-0.0118**	-0.00204	-0.0210**
	[0.0627]	[0.226]	[0.0197]	[0.125]	[0.0692]	[0.318]	[0.0166]	[0.0900]	[0.0160]	[0.0940]	[0.000837]	[0.00485]	[0.00154]	[0.0104]
Distance to Paris * Year Fixed Effects	-4.92e-05	-0.000104*	4.33e-06	1.92e-05	0.000138**	0.000178**	-7.54e-05***	-7.46e-05***	-7.64e-05***	-7.68e-05***	-2.50e-06***	-3.85e-06***	-2.20e-06	-4.40e-06**
	[4.68e-05]	[5.55e-05]	[1.43e-05]	[1.89e-05]	[6.39e-05]	[7.06e-05]	[2.15e-05]	[1.93e-05]	[2.16e-05]	[2.00e-05]	[8.64e-07]	[1.16e-06]	[1.50e-06]	[2.02e-06]
Share of Carboniferous Area * Year Fixed Effects	1.12e-06	3.12e-05	-2.10e-06	-1.03e-05	-2.96e-05	-4.88e-05*	-1.77e-06	-2.15e-06	-4.93e-06	-4.71e-06	-2.10e-07	3.95e-07	-4.53e-07	5.29e-07
	[1.34e-05]	[1.92e-05]	[7.72e-06]	[1.04e-05]	[2.10e-05]	[2.64e-05]	[5.32e-06]	[7.69e-06]	[5.26e-06]	[8.09e-06]	[2.33e-07]	[3.87e-07]	[4.52e-07]	[7.67e-07]
Male Catholic Clergy	-0.0291	0.505*	0.0501	-0.0973	-0.382*	-0.727*	0.0396	0.0329	0.0150	0.0190	-0.000324	0.0109*	0.00438	0.0226*
	[0.153]	[0.283]	[0.0938]	[0.153]	[0.231]	[0.375]	[0.0584]	[0.113]	[0.0608]	[0.114]	[0.00287]	[0.00568]	[0.00594]	[0.0121]
GDP per capita	-0.621**	0.752	-0.183	-0.553	-0.887**	-1.757**	0.129	0.111	0.0592	0.0694	-0.0152***	0.0117	-0.0289***	0.0148
	[0.271]	[0.633]	[0.132]	[0.344]	[0.436]	[0.891]	[0.117]	[0.265]	[0.121]	[0.279]	[0.00443]	[0.0118]	[0.00861]	[0.0252]
Year- and High-School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	0.289		0.002		0.037		0.118		0.099		0.246		0.326	
Clusters	394	394	394	394	394	394	394	394	394	394	394	394	394	394
Observations	945	945	933	933	954	954	948	948	948	948	976	976	976	976
First stage: the instrumented variable is Horse Power of Steam Engines														
Mines		0.193***		0.188***		0.193***		0.191***		0.191***		0.190***		0.190***
		[0.0340]		[0.0347]		[0.0341]		[0.0340]		[0.0340]		[0.0338]		[0.0338]
1st stage F-stat		32.111		29.400		32.125		31.589		31.589		31.429		31.429
Reduced Form: the dependent variable is														
	Subventions to High-Schools						High-School		High-School		Central State Scholarships		All Scholarships	
	from the Central State		from the Departements		from the Communes		Total Spending per High-School Pupil		Total Receipts					
Mines		-0.139***		0.0282		0.100*		-0.000781		-0.00216		-0.00216		-0.00216
		[0.0391]		[0.0220]		[0.0597]		[0.0173]		[0.0181]		[0.0181]		[0.0181]

Note: This table presents OLS, IV and and reduced form regressions relating the horse power of steam engines to public spending on secondary schooling per high-school pupil in 1865, 1876 and 1887. The relationship accounts for GDP per capita and the number of male Catholic clergymen as well as the distance to Paris and the share of carboniferous area interacted with year-fixed effects. *** denotes statistical significance at the 1%-level, ** at the 5%-level, * at the 10%-level, for two-sided hypothesis tests.