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Primary education, industrial activities and economic growth in nineteenth-century France

Adrien Montalbo

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Adrien Montalbo. Primary education, industrial activities and economic growth in nineteenth-century France. Economics and Finance. École des hautes études en sciences sociales (EHESS), 2019. English. NNT : 2019EHES0163 . tel-03168306

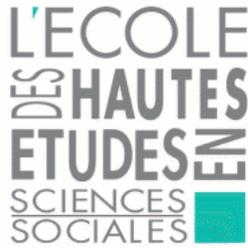
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École des Hautes Études en Sciences Sociales

ÉCOLE DOCTORALE DES HAUTES ÉTUDES EN SCIENCES SOCIALES
CENTRE DE RECHERCHE PARIS-JOURDAN SCIENCES ÉCONOMIQUES

THÈSE

Pour obtenir le grade de
Docteur de l'École des Hautes Études en Sciences Sociales

Discipline : Sciences Économiques

Adrien MONTALBO

*PRIMARY EDUCATION, INDUSTRIAL ACTIVITIES AND ECONOMIC
GROWTH IN NINETEENTH-CENTURY FRANCE*

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Date de soutenance : le 28 novembre 2019

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Remerciements

Je voudrais tout d'abord remercier mon directeur de thèse, Jérôme Bourdieu, ainsi que Lionel Kesztenbaum. Tous deux ont accepté de m'encadrer depuis le master et ont toujours été disponibles pour me conseiller, m'encourager et m'orienter. Ce que je sais aujourd'hui de la recherche en économie, je le leur dois en grande partie.

Mes remerciements vont aussi à Gabriele Cappelli, Charlotte Le Chapelain, Eric Maurin et David Mitch pour avoir accepté de faire partie du jury. Leurs conseils ont grandement contribué à améliorer la qualité de cette thèse.

Je n'aurais certainement pas été capable de réaliser la même thèse sans l'aide précieuse d'Anne-Marie Chartier et d'André Oliva qui m'ont permis d'accéder à leur travail sur les données issues de la loi Guizot. Je les en remercie chaleureusement.

Je remercie également tous les membres du milieu universitaire qui, au cours des séminaires ou de discussions plus informelles, m'ont orienté vers des pistes nouvelles. Sur ce point, je ne peux évidemment pas manquer de remercier tout particulièrement Quentin Lippmann et Thomas Douenne pour leur aide et leur amitié. Je remercie aussi tous les membres du bureau R4-72.

Je tiens aussi à adresser mes remerciements à ma famille, en particulier mes parents Fernando et Gisèle, ainsi que mes frères Aurélien et Florian. Si ces années d'études et de thèse dans la capitale se sont avérées plutôt faciles à vivre, c'est aussi sans doute grâce aux moments passés auprès d'eux lors des retours dans mes montagnes natales.

Bien sûr, des liens d'amitié forts m'unissent aussi à Paris. Il me semble bien inutile de tous les nommer ici, ils se reconnaîtront à coup sûr.

Enfin, je tiens à remercier Marie, pour des raisons que la pudeur passera sous silence.

Summary

In this thesis, I study the links between primary education, industrial activities and economic development in nineteenth-century France.

In the first chapter, I investigate the rationale behind the expansion of primary education in France, from the Revolution to the Guizot Law of 1833. If the unequal educational achievements between French departments have been deeply studied and related to economic, geographic and cultural factors, nearly nothing has been said about the influence of primary schools' functioning on these achievements. Thanks to the use of precise data at the level of municipalities and primary schools themselves, I show that, after the Revolution, municipalities took over the control of primary schooling in areas previously well-endowed in primary schools. By subsidising teachers, they contributed to alleviate the schooling fees and therefore the cost of education for families. This contributed to increase enrolment rates. Also, municipalities subsidising schools were recruiting and attracting more qualified and efficient teachers, which contributed to increase teaching quality and the accumulation of human capital. Municipal investment, determined both by demand and supply forces, is therefore a key factor in understanding the development of primary schooling in nineteenth-century France.

The second chapter focuses on the relations between primary education and industrial activities in early nineteenth-century France. I investigate in particular how these activities influenced the presence of primary schools, enrolment rates and human capital accumulation within municipalities. To do so, I use the presence of mineral deposits to instrument the location of factories. I find that industrial activities favoured the presence of schools through an indirect income effect. A higher industrial production was leading to a higher amount of taxes collected by municipalities, and therefore to a greater financial capacity to subsidise primary schooling. However, I find no positive link between industry and enrolment rates or human capital accumulation. On the contrary, I present evidence of a negative association between some industrial sectors, mining and textile in particular, and enrolment rates.

In the third chapter, I study the influence of primary schooling on economic development in nineteenth-century France and up to World War I. To do so, I use three different estimation strategies. Firstly, I exploit a regression discontinuity induced by the Guizot Law to determine the impact of primary school's creation. Secondly, I use the proximity of municipalities to printing presses established by 1500 to instrument primary schooling achievement. Both methods return a positive effect of education on the subsequent growth of municipalities. Finally, I use a matching technique to evaluate the influence of schooling quality on growth, which I also find to

be positive. Therefore, basic education and the acquisition of elementary knowledge and skills contributed to the development of French municipalities during the century of industrialisation and modernisation.

Field of study : Economics

Key-words : Primary Education, Industry, Economic Development, Nineteenth Century

Résumé

Cette thèse vise à étudier les liens entre instruction primaire, activités industrielles et développement économique en France au XIXe siècle.

Au sein du premier chapitre, j'étudie les caractéristiques de l'instruction primaire et de son expansion en France, entre la période révolutionnaire et la loi Guizot de 1833. L'inégal développement de l'instruction primaire a été profondément étudié au niveau départemental. L'influence de la richesse économique et de caractéristiques géographiques ou culturelles est aujourd'hui bien connue. Toutefois, très peu d'études ont tenté de mesurer l'influence du fonctionnement des écoles primaires sur le développement de l'instruction. Grâce à l'utilisation de données très précises au niveau des communes et des écoles elles-mêmes, je montre que, suite à la Révolution, les communes ont pris le contrôle de l'instruction dans les régions où les écoles étaient déjà fortement concentrées. Celles-ci ont alors contribué à abaisser les frais d'écolage et donc le coût de l'éducation pour les familles en subventionnant les écoles primaires et les enseignants. Ceci a contribué à augmenter le taux de scolarisation dans les communes concernées. Des enseignants plus qualifiés et compétents étaient également recrutés dans les écoles subventionnées par les communes, ce qui contribua à accroître le qualité de l'instruction et l'accumulation du capital humain. L'investissement municipal, déterminé à la fois par des effets d'offre et de demande, constitue donc un facteur essentiel pour comprendre le développement de l'instruction primaire au XIXe siècle en France.

Au sein du deuxième chapitre, j'étudie les relations entre activités industrielles et instruction primaire en France au début du XIXe siècle. Je me concentre en particulier sur l'influence de l'industrie sur la présence d'écoles, les taux de scolarisation ainsi que l'accumulation du capital humain au niveau des communes. Pour ce faire, j'utilise la localisation de minerais afin d'instrumenter la présence d'industries. Celles-ci ont eu un impact positif sur la présence d'écoles primaires à travers un effet de richesse indirect. Une production industrielle importante permettait aux communes de prélever davantage de ressources sur cette production par le biais de la taxation, ce qui augmentait à son tour les possibilités d'investissement dans l'instruction. Je ne trouve toutefois pas d'effet positif de l'industrie sur la scolarisation ou l'accumulation du capital humain. Au contraire, certains secteurs industriels, particulièrement le textile et les activités minières, étaient négativement corrélées aux taux de scolarisation au début du XIXe siècle.

Dans le troisième chapitre, j'étudie l'influence de l'instruction primaire sur le développement économique des communes en France au XIXe siècle et jusqu'à la Première Guerre mondiale.

J'utilise pour cela trois techniques d'estimations différentes. Tout d'abord, je me sers de la loi Guizot de 1833 pour mesurer l'influence de la création d'écoles primaires sur la croissance des communes. Ensuite, j'utilise la proximité des communes aux imprimeries implantées avant 1500 pour instrumenter l'expansion de l'instruction primaire. Les deux méthodes permettent de conclure à une influence positive de cette instruction sur le développement des communes au XIXe siècle. Enfin, j'utilise une technique d'appariement pour mesurer l'effet de la qualité de l'instruction sur le développement. Cette dernière a également eu un effet positif sur la croissance des communes. L'instruction primaire, et donc l'acquisition de connaissances "de base" ou élémentaires, a donc contribué à la croissance des communes françaises au cours du siècle d'industrialisation et de modernisation.

Discipline : Sciences économiques

Mots-clés : Instruction Primaire, Industrie, Développement économique, Dix-neuvième siècle

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Main Introduction

Education and Economic Development

Within the research agenda in economics, education plays an important role. Whether at the microeconomic or macroeconomic level, its relation with many outcomes, such as individual earnings (Angrist and Krueger, 1991), (Card, 1999), innovation (Lucas, 1988), (Romer, 1990), economic growth (Krueger and Lindahl, 2001), (de la Fuente and Doménech, 2006), (Cohen and Soto, 2007) or urbanisation (Glaeser et al., 1995), (Glaeser et al., 2004) has been deeply studied. What stems from these analyses is that education contributes positively to the development of a society by prompting the emergence of new ideas, helping their diffusion, by enhancing the accumulation of human capital and improving the skills valuable to people on the labour market. Therefore, as education is deemed of extreme value, economists also turned their eyes towards the determinants of educational achievement. Class size and teachers' remuneration or qualification level have been particularly studied recently (Angrist and Lavy, 1999), (Nickell and Quintini, 2002), (Britton and Propper, 2016). If these factors matter to increase education outcomes, teachers' individual quality, which is harder to quantify and evaluate, seems also to be important (Hanushek et al., 2005). At the macroeconomic level, education quality also gained interest as economic growth has been found to be more closely related to students' performance evaluated by tests scores than to the number of schooling years of the working population (Hanushek and Kimko, 2000), (Barro, 2001), (Hanushek and Woessmann, 2012). Many works are also related to the debates on equality of opportunity (Roemer and Trannoy, 2015) and misallocation of talent (Hsieh et al., 2013).

This abundant literature focuses rather on the second part of the twentieth century. Very recent data on developed countries are for example used to measure individual returns to schooling, the determinants and impact of schooling quality, while the macroeconomic analysis of country growth often takes the 1960 and 2000 years as time bounds. Another strand of the literature analyses the consequences of compulsory schooling laws in developing countries (Duflo, 2001), or adopting a historical perspective on developed ones (Goldin and Katz, 2000). Issues of data availability and quality explain a high share of the research division.

Education in Economic History

Education has also been highly mobilised to explain historical economic development. An important question raised in this field concerns the determinants of educational development and literacy spread. The unequal level of economic resources has been identified as one of the major explaining factors (Lepetit, 1986), (Grew and Harrigan, 1991). Since education was rarely free until the end of the nineteenth century, the purchasing power of families had a great impact on the access to education. This is also valid at the country level. Directly related to this point, more unequal land distribution had a negative effect on literacy (Banerjee and Iyer, 2005), (Galor et al., 2009), (Cinnirella and Hornung, 2016), (Beltrán Tapia and Martínez-Galarraga, 2018). Trading activities increasing the need and returns to literacy along with the cultural influence of cities influenced positively the spread of education (Julia, 1970). Long-term religious factors, especially the effect of Protestantism and the Counter-Reform, also impacted positively education (Furet and Ozouf, 1977), (Becker and Woessmann, 2009).

Another debated topic in this field consists in evaluating the determinants, the characteristics and the consequences of industrialisation, mainly in European countries and the US. Two main questions were raised on this point: how did industrial activities impact primary schooling and literacy? Was education important for the development of the industrial sector? These questions have been mostly discussed for the British case, and the textbook example of Lancashire, where industrialisation had arguably the most pronounced consequences on society. Early studies have found a strong negative correlation between industry and literacy (Sanderson, 1972), (Nicholas and Nicholas, 1992). However, more recent analyses tend to qualify this effect as it is hard to show that industry itself impacted negatively schooling achievements (de Pleijt et al., 2016). Moreover, industry may have positively influenced the development of education through an income effect on local and families' resources (Franck and Galor, 2017). Its impact was most likely negative on child work, diminishing the age at which children started working and worsening their labouring conditions compared to the agricultural sector (Humphries, 2010). Concerning the second question, industrial activities, especially in the first part of the nineteenth century, had not been found to be highly skill-demanding (Mitch, 1993). Basic knowledge may have increased productivity, but this was certainly limited to a restricted number of jobs. Upper-tail knowledge and scientific culture influencing innovations is likely to have been more closely related to the development of industry (Squicciarini and Voigtländer, 2015), (Jacob, 1997) along with a more developed and efficient apprenticeship system (Meisenzahl and Mokyr, 2012), (Ben Zeev et al., 2017), (de la Croix et al., 2018).

Industrial activities have often been taken as a proxy for economic development in studies focusing on the nineteenth century. Basic education has for example been shown to have influenced the industrial development and innovations in Prussia at that time (Becker et al., 2011), (Cinnirella and Streb, 2017). However, there are only a few analyses trying to relate education to economic growth during this century of modernisation. Moreover, they often investigate primarily the population growth of big towns (Simon and Nardinelli, 1996), (Simon and Nar-

dinelli, 2002). This is understandable because of the scarcity of data at the level of smaller municipalities, either on education or economic resources. Also, it is hard to link education and agriculture at a disaggregated level. However, a branch of the economic history literature evaluated the association between book production, taken as a proxy for upper-tail knowledge, and the growth of countries. During the 1500-1800 time period, book production was positively and significantly linked to economic development (Baten and van Zanden, 2008), (de Pleijt and Zanden, 2016). The relation between basic primary education, for which a sharp increase took place during the nineteenth century, and economic development remains therefore an open question.

The Thesis's Research Questions

The contribution of this thesis revolves around these topics. The three major objectives are as follows. A first objective is to study the determinants of the spatial diffusion of primary education in France during the nineteenth century. Indeed, educational attainments, whether proxied from the end of the seventeenth century by marriage signature rates or measured by enrolment and the presence of schools in the nineteenth century, remained higher in the north-eastern part of France compared to other regions. A line going from Saint-Malo to Geneva has long since been identified in the literature (Dupin, 1826). North of the line, education was far more developed than south of it, except for the Rhone valley and the Gironde region which were also well-endowed in primary schools. Improving the understanding of these long-lasting differences is therefore the first aim of the thesis. More precisely, the objective is to study why these differences remained stable after the Revolution and to refine the analysis by identifying factors which influenced the expansion of education at the municipality level.

The second ambition is to analyse the relations between industrial activities and primary schooling in the early nineteenth-century France, when industry began to greatly develop in this country. Districts¹ with a highly developed industry, for instance in the Nord department of France, were found to be characterised by lower enrolment rates (Leblond, 1970). Also, social observers of that time (the most prominent being Louis-René Villermé) have extensively described the dreadful working conditions of children within manufactures, along with the negative impact of industrial tasks on children health and education (Villermé, 1971). The first law regulating child labour was passed in 1841 in France. However, its implementation often remained extremely partial (Weissbach, 1977). The potential negative consequences of industry on primary schooling may therefore have been strong until the Ferry Laws of 1881-1882 which made primary instruction compulsory.

The third aim of the thesis is to evaluate the contribution of primary education to the economic development of municipalities in France during the nineteenth-century and up to World War I. Most of the studies related to this point focuses on city growth. However, the vast

¹These districts correspond to an administrative subdivision of departments, called *arrondissements départementaux* or *sous-préfectures* in French.

majority of municipalities in France was sparsely populated in the nineteenth century. In 1800 for example, 95% of them were endowed with less than 1 839 inhabitants. In 1851, this figure amounts to 2 517, 2 613 in 1901. Moreover, the urban population overtook the rural one only in 1931 in France. Therefore, focusing on city growth would miss much of the potential effect of education on local economic development. As the educational achievement was highly differentiated between regions and municipalities in France, it is interesting to evaluate if an early investment of families or local authorities in education did impact or not the subsequent growth of municipalities.

Sources and Data

In order to pursue these three objectives, a large newly digitalised dataset at the municipalities and primary schools level is used. These data are related to the first national law on primary education passed in France, the Guizot Law of 1833. Under the supervision of the French Minister of Education François Guizot, this law made mandatory for each municipality more than 500 inhabitants to open and finance a primary school for boys. The funds used to maintain these schools could come from the municipality own resources collected through taxation or from a financial assistance of departments. Before 1833, primary schools could be totally financed by the monthly schooling fees paid by families, in which case they were said to be private, or by a mix between these fees and the municipal resources, the school was then said to be public. A law passed in 1816, defining the requirements to obtain a teaching certificate, was regulating the opening of primary schools (Mayeur, 2004).

Just before the Guizot Law was passed, 490 inspectors were sent throughout France in order to inspect all primary schools, both public and private. All departments came under scrutiny, except Corsica. The aim of this survey was to collect detailed information on the state of primary schooling in order to implement the law in the best possible way. Therefore, each inspector had to identify in which municipalities a primary school was present, but also to describe its characteristics. The number of pupils, the average schooling years, the level of the fees, the endowment of teaching material, the characteristics of the potential municipal support to the school, ... were to be reported. Alongside schools' characteristics, the inspectors also had to collect information on teachers. Their age, name, level of certification and wealth for example are reported in the survey. A qualitative evaluation of teaching quality and progress of pupils was also performed by the inspectors. The amount and precision of information on primary education that can be drawn from this survey are therefore very high.

From the survey, a *Report to the King* was published, which detailed the results for all French departments (Guizot, 1834). Only some of the questions asked in the initial survey, those deemed of major interest, were aggregated in this report. From the initial individual (at the level of each primary school) forms, the data were computerised for 22 departments and 8 129 municipalities. These departments are: Ardèche, Ardennes, Cher, Corrèze, Côtes-du-Nord, Finistère, Gard, Gers, Indre, Indre-et-Loire, Loire-Inférieure, Loiret, Lozère, Marne, Morbihan,

Nièvre, Oise, Bas-Rhin, Saone-et-Loire, Seine-et-Marne, Deux-Sèvres and Vaucluse. At least one primary school was present in 4 836 of them (59.5%). This project was initiated by the *Service d'Histoire de l'Éducation* of the I.N.R.P, which collected data for the academies of Nantes, Bourges and Nîmes. I collected myself all the other departments (eleven of the twenty-two). The departments selected are representative of France for what regards the primary education characteristics that will be under scrutiny in the thesis.

Presentation of the Thesis

First Chapter

The first part of the thesis is dedicated to understanding primary schooling development in France. I focus on the period going from the Revolution to the Guizot Law of 1833. However, as the spatial distribution of education remained strongly stable in France until at least the mid-nineteenth century, the conclusions drawn from the analysis have a longer scope. In this first chapter, I don't evaluate the long term determinants, religious influence for example, of literacy or primary schools' presence. I rather look at the functioning of schools to identify the factors that could have contributed to increase the stability of their presence. Indeed, the educational division of French territory is really old and globally stable at least from the end of the seventeenth century. Also, it is closely associated with unequal economic resources.

I therefore look more precisely at the way primary education was operating from the Revolution to the Guizot Law, in the absence of any law regulating primary schooling. The interesting point is that the Revolution suppressed taxes collected by the clergy, which were used to finance primary education. This level of schooling was mainly controlled and delivered by parish priests and religious institutions before the Revolution. From the Revolution to 1833, schools could be private and only financed by fees or public and financed by a mix between schooling fees and municipal subsidies as previously mentioned. I make the hypothesis that the way schools were funded influenced their characteristics and the educational achievements of pupils. Without doing so, one could only say that schools simply remained more concentrated in richer areas where parents wanted to school their children and could afford it. This is true, but not the end of the story.

What I show in the first chapter is that, after the Revolution, municipal authorities took over the control of instruction in areas previously well-endowed in primary schools. Education was therefore more often publicly subsidised in these areas and its financing burden shared by all inhabitants through taxation. This had a crucial impact on primary schooling. Indeed, when part of the teachers' remuneration was provided by the municipalities, local authorities could negotiate with them the level of schooling fees parents had to face. I find that these fees were lower in public schools than in their private counterparts. This lower cost of education made schooling affordable for more families and was for that reason associated with higher enrolment rates. Also, I find that teaching conditions were better and human capital accumulation higher

in the schools provided with municipal grants. Pupils stayed for a longer number of years in public schools and were learning more subjects than in the private ones.

Public investment in primary schooling, driven by both supply and demand factors, is therefore a key element to understand the uneven distribution of schools, enrolment rates and knowledge accumulation in France during the nineteenth century. Indeed, even if differences in schools' presence would have existed without municipal investment, this latter impacted positively primary schooling and human capital accumulation. The unequal educational achievement between departments and municipalities in France was consequently widened by public subsidies. This also contributed to increase the stability of this differentiated development until late into the nineteenth century.

This chapter adds to the existing literature on the determinants of educational expansion by showing that the organisation of the schooling system may highly impact enrolment rates and human capital accumulation. Economic, social and geographic determinants are essential in explaining the differentiated educational achievements between French regions or municipalities. However, even controlling by these characteristics, municipal investment still greatly influenced schooling expansion. At the same level of economic resources, for example, a municipality subsidising primary schools was characterised by higher enrolment rates, a higher teaching quality and accumulation of human capital. Understanding the national or local institutional features of schooling systems appears therefore to be essential in accounting for the expansion of education during the 19th century.

Second Chapter

In the second chapter of the thesis, I analyse the impact of industrial activities on primary instruction in early nineteenth-century France. To do so, I rely on the Industrial survey of 1839-1847. This survey reports the location and characteristics of all manufactures with more than ten workers in France at that time. This threshold was meant to avoid mixing industry and craftsmanship. This survey was conducted a few years after the Guizot survey on education. This is why I have to assume that factories' location remained stable between the two surveys. In the analysis, I often focus on large factories to reinforce the reliability of this assumption. I study the impact of industrial activities both on primary schools' presence and on enrolment rates. My initial assumption was that industrial activities were not likely to influence positively the demand for schooling. I expected to find a negative relation between the two in link with child labour. However, the effect on the supply of schools was less clear theoretically. Factories were indeed generating economic resources potentially useful for municipalities to attract teachers, or for parents to pay the fees.

In this chapter, I use an instrumental variable (IV) approach. I collected data on the location of deposits in the twenty-two departments for which I have data on education at the level of municipalities. I then matched the two datasets and used deposits' presence to instrument industrial activities. I first find a positive effect of factories' presence on the location of primary

schools. This impact was due to an increase in the supply of schools financed by municipalities caused by industrial activities. Indeed, these activities contributed directly to municipal resources through the *patente*, a tax collected on industrial production. As a result, municipalities where this production was high were benefiting from higher economic resources coming from taxation. The positive impact of industry on primary education was therefore working through an increase in the supply of public schools financed partly by municipalities. An indirect positive income effect accounts for this relation.

However, I find no significant association between industry, the demand for schooling and the accumulation of human capital. I show that the presence of industry was not significantly linked with enrolment rates, while mining activities were negatively influencing this enrolment. I provide indications that this negative association was likely to be due to the employment of children within factories. Indeed, there was a negative correlation between the presence of industrial sectors relying highly on child work in a given municipality and the enrolment within primary schools. Two sectors contributed the most to this negative correlation, textile and building. Finally, I find no significant impact of industry on the number of schooling years. The presence of factories was therefore not associated with a higher volume of knowledge learnt within primary schools. I interpret this as being due to the fact that industry was not highly skill-demanding in the first part of the nineteenth century in France, and, for that reason, didn't enhance significantly the accumulation of human capital, at least within primary schools.

This work sheds a new light on the relation between industry and education during the first phase of industrialisation. Industrial activities influenced positively the supply of schools through an income effect, but had at best no impact on the demand for schooling. Therefore, "basic" or elementary knowledge and skills acquired within primary schools appear to have been highly unrelated to industrial production, at least in the first part of the 19th century. Therefore, this chapter adds to the understanding of economic development in early nineteenth-century France and on the interaction between economic activities, industry and education.

This analysis also complements the first chapter by identifying a determinant of primary schools' presence and of public investment in primary schooling. If economic resources have long been associated with schooling expansion, the case of industry remained debated. In this chapter, I show that richer municipalities had indeed a higher probability to be characterised by the presence of a school, but that this effect was working through the public involvement in education. Without this involvement, the impact of industry would most of likely have been weaker. Therefore, it is the association between resources and municipal investment which can account for the development of primary schooling in early nineteenth-century France.

Third Chapter

The third chapter focuses on the association between primary schooling and economic development in nineteenth-century France and until World War I. To do so, I collected data on the

economic resources of municipalities. These data are coming from publications by the Ministry of the Interior entitled *La Situation Financière des Communes de France et de l'Algérie*, issued each year from 1878 to 1929. These publications provide information on the amount of taxes collected by municipalities. In 1791, the Assemblée Constituante implemented a land tax, a personal property tax on incomes coming from other sources than land and commercial activities and a patente tax on these commercial and industrial resources. An additional tax on the number of doors and windows of habitations was later implemented in 1798. These four taxes, known as the *Quatre vieilles*, constituted the direct "contributions", as they were called, entering the municipalities' budgets. This system remained remarkably stable all along the nineteenth century. Big towns were also benefiting from taxes on products imported and sold within the delimitations of the municipalities, known as the *octrois*. All these taxes should reflect accurately the economic resources of municipalities. I digitalised the 1881 and 1911 years. I selected two years for several reasons. First, it enables me to check if the results obtained are not linked to a particular year. Second, I am able to study the persistence of the effect of education on resources. Lastly, knowing the timing when education potentially influenced development is useful in specifying the transmission channels between the two phenomena.

The effect I measure in this chapter is related to an early investment in education by municipalities and families. I evaluate if municipalities where primary schooling was more developed in 1833, before any legislation regulating primary education, were characterised by a higher level of economic resources per capita in 1881 and 1911. Therefore, I assess if education contributed significantly or not to development at the local level during the nineteenth century. To do so, I take the average number of schooling years within municipalities and enrolment rates as indicators of educational achievement. I also investigate the association between schooling quality, proxied by the potential municipal investment in primary schools, and the level of future resources. Indeed, by providing teachers with a fixed salary, an accommodation, a classroom or another occupation within the municipality, local authorities were considerably increasing teachers' financial stability and improving their working conditions. As shown in the first chapter, this was related to a higher teaching quality as evaluated by the inspectors from the Guizot survey. Therefore, this work builds on this first chapter to evaluate the influence of schooling quality on development.

I implement different estimation strategies in this chapter. First, I use a feature of the Guizot Law of 1833 to estimate the impact of education on development: the law made mandatory for any municipality more than 500 inhabitants to open a primary school for boys. Thanks to the survey on primary schooling, I know which municipality around this population threshold had no schools at that time. Therefore, I use a regression discontinuity around the 500-inhabitant threshold for municipalities with no schools in 1833. Municipalities just above the threshold had to open a school, while the others below had no legal obligation to do so. I find a positive and significant effect of being just above the legal threshold on future resources, with a magnitude of around 2 francs per capita. This corresponds to one-third of a standard deviation in resources.

Second, I use an instrumental variable strategy. In order to instrument primary education, I use the proximity of municipalities to printing presses established from 1450 to 1500. There are a number of qualitative evidence linking the development of literacy and the advent of the printing press. I also argue that the proximity to the press was not likely to be linked to the previous development of municipalities where the press was not established. This part of the chapter therefore relies on the assumption that economic spillovers were concentrated to the proximity of towns with the printing press, while the educational ones were likely to have spread farther away. I argue in the chapter that this is very likely to be the case. I find a positive association between the instrument and primary schooling in 1833. Then, the IV estimations indicate that one more schooling year in 1833 was related to an increase of around 15% in the economic resources per capita of municipalities at the end of the century. A one-percent increase in enrolment was associated with a 0.4% increase in resources. Primary schooling was therefore an important factor behind the growth of municipalities during the nineteenth century in France.

Finally, using a matching estimation technique, I find that municipalities which invested in education had a higher level of economic resources at the end of the century, compared to municipalities with a similar education achievement but where schools remained private. Providing teachers with a fixed salary or another municipal occupation were linked to future economic resources. Therefore, schooling quality also mattered for the future development of municipalities. Teachers' qualification level seems on the contrary not to have mattered in this perspective.

This chapter sheds a new light on the relation between education and economic development during the century of industrialisation and modernisation. Indeed, existing studies identified a positive association between apprenticeship or upper-tail knowledge and the onset of industrialisation. Also, there seems to have been no strong link between elementary knowledge, skills, and economic development before the mid-nineteenth-century. In this chapter, I show that primary schooling and basic education contributed to the growth of municipalities during this century in France, and therefore that their influence on technology adoption and productivity is very likely to have been strong and increasing at that time. This is in line with recent studies on Prussia showing an association between literacy, elementary knowledge and industrial development.

This chapter builds greatly on the first one and complements the second. Indeed, I use the positive association between public investment in education, teaching quality and human capital accumulation exhibited in the first chapter to evaluate the effect of education quality on economic development. Also, if primary schools' presence was positively associated with industrial activities but not with human capital and enrolment rates in the early nineteenth-century France, the results of this chapter show that this relation is very likely to have evolved later during the century. Either through an effect on productivity or technology adoption, industrial activities are likely to have been positively influenced by basic education during this time period. I also try and discuss the potential transmission channels between these two phenomena in this chapter, along with the influence of education on agriculture.

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Chapter 1: Schools without a law: primary education in France from the Revolution to the Guizot Law

Abstract

The French Revolution had a substantial impact on the functioning of primary schools as it suppressed one of their major funding sources, taxes collected by the clergy. Nonetheless, the geographical distribution of schools and enrolment rates remained relatively stable until late into the nineteenth century. In this article, I show that understanding the reorganisation of primary schooling after the Revolution is essential in accounting for these long-lasting variations in educational attainment. By using a new database at the level of primary schools, I first show that municipalities took over the control of instruction in areas well-endowed in economic resources and where schools were more concentrated before the revolutionary time period. Secondly, I demonstrate that, by subsidising schools, municipal authorities acted in favour of a fall in schooling fees, lowering the average cost of education and therefore increasing enrolment rates. Both supply and demand factors can account for this relation. Finally, I show that teaching conditions were better and human capital accumulation higher in the schools provided with municipal grants. Public investment in primary schooling is therefore a key element to understand the uneven distribution of schools, enrolment rates and knowledge accumulation in France during the nineteenth century.

1 Introduction

Identifying the factors which contributed to the development of primary education and literacy has been, and still is, a major objective of economic and social history. One of these factors is obvious, laws on compulsory education. These laws triggered the convergence between regions or countries in terms of educational achievements. Therefore, scholars tried to evaluate the determinants of schooling expansion in the absence of such laws. Democratic transitions is one of the factors put forward in the literature (Bourguignon and Verdier, 2000), (Glaeser et al., 2007)². Military rivalry, and especially defeats, have also influenced positively primary schooling through pressure on educational reforms (Aghion et al., 2019). For what regards economic factors, the second phase of industrial revolution impacted positively education thanks to an increased complementarity between formal skills and industrial tasks (Galor and Moav, 2006), (de Pleijt et al., 2016) (Diebolt et al., 2017), (Franck and Galor, 2017). Inequality in land distribution, on the contrary, decreased the presence of institutions promoting human capital as landlords were more reluctant to its development and to social change (Banerjee and Iyer, 2005), (Galor et al., 2009). A higher concentration in land ownership was also associated with a lower private demand for education (Beltrán Tapia and Martínez-Galarraga, 2018), (Cinnirella and Hornung, 2016). Religion factors also mattered as Protestantism influenced positively education (Becker and Woessmann, 2009), (Becker and Woessmann, 2010). The accumulation of human capital associated with these factors mattered for cities, regions or countries, leading to higher growth rates, especially during the pre-industrial era (Cipolla, 1969), (Dittmar, 2011), (de Pleijt, 2018), (Dittmar and Meisenzahl, 2019). High educational achievements have notably been associated to the Little Divergence between England, the Low Countries and the rest of Europe over the 1300-1800 time period (Baten and van Zanden, 2008), (de Pleijt and Zanden, 2016)³.

In this work, I show that taking into account the specific institutional features of the educational system in a given country is also essential to understand its development. To do so, I focus on early nineteenth-century France, at the level of municipalities and primary schools themselves. More precisely, the period going from the French Revolution to the Guizot Law of 1833 comes under scrutiny in this work. Indeed, the Revolution in France constituted a considerable shock for primary schooling. To this date, the existence of many schools was depending on the resources collected by the clergy. Especially north of a line going from Saint-Malo to Geneva, teachers were mostly assisting parish priests along with their educational activities, serving as mass cantors for example. Part of their remuneration thus came from taxes dedicated to the clergy, as the tithe. After the Revolution, these taxes were suppressed and teachers could, from then on, only rely on tuition fees (known as the *écolage*) paid by parents, and on the potential

²This idea is debated as democracy doesn't necessarily have a positive impact on public policies and education (Mulligan et al., 2004). Schooling could even be favoured by dictatorships as a means of indoctrination (Lott, 1999).

³See also (van Lottum and van Zanden, 2014) on the importance of skills in the maritime sector before the industrialisation and (Squicciarini and Voigtländer, 2015) for a positive effect of upper-tail knowledge on city growth and industrial performance during the onset of industrialisation in France.

investment of municipalities in primary schooling. If the school was financed only by fees, it was said to be private. On the contrary, if the municipality at stake was investing in education, the school was public⁴.

Despite fierce debates during the nineteenth century to assess the effect of the Revolution on primary schools (Allain, 1881), (Gontard, 1959)⁵, the geographical differences in their concentration remained stable until the Guizot Law of 1833 (Dupin, 1826), (D'Angeville, 1836), (Babeau, 1885), (Fleury and Valmary, 1957), (Houdaille, 1977), (Graff, 1987) and even until late in the nineteenth century. This law made compulsory to open a primary school for boys in every municipality more than 500 inhabitants. North to the Saint-Malo/Geneva line, the number of schools and enrolment rates remained highly superior to the ones south of this very line (except for the Rhone Valley and the Aquitaine region which were also characterised by a relatively good presence of schools). However, little has been said, either in the historical or economic literature, to explain the strongly stable pattern of primary instruction in France between the Revolution and the Guizot Law. Shedding lights on this issue is of prior importance to understand the history of education in France all along the nineteenth century. Indeed, even if a convergence already existed between departments (counties) (Diebolt et al., 2005), the geographical differences in educational attainment were long-lasting and perpetuated at least until the Ferry Laws of 1881-1882, which made enrolment in primary schools mandatory for children. The main objective of this work is to evaluate how primary schooling recomposed itself after having been deprived of one of its major source of funding. This will help to understand how the geographical differences in education spreading were maintained and even reinforced after the Revolution, and why some areas kept an educational edge over the others until late into the nineteenth century.

Several social and economic factors that influenced positively the presence of schools have already been identified in the literature. The extensive use of a non-written patois, as in Brittany for example, was shown to have been detrimental to primary schooling (Furet and Ozouf, 1977b), as well as the average altitude of municipalities and a higher population dispersion. Indeed, these two characteristics were often associated with poor-quality byroads and higher travelling distances, which made the continuous attendance of children harsher (Meynier, 1970), (Gontard, 1959). This was influencing negatively enrolment rates and the amount of fees perceived by teachers, making their presence in the municipality unstable. Economic factors were also clearly linked to the spread of primary schooling. Many indicators as the amount of taxes on doors and windows (D'Angeville, 1836), commercial networks proximity (Julia, 1970) or the concentration of skilled occupations (Corbin, 1975) were associated with a stronger presence of primary schools at the department or district level⁶. The same was true for industrial activities in the second part of the century (Diebolt et al., 2017), (Franck and Galor, 2017). A

⁴I will sometimes use the term "subsidised" instead of public in order to avoid repetitions.

⁵The core point of the debate was to know if the suppression of taxes dedicated to the clergy impacted negatively, and by how much, the presence of schools.

⁶The districts indicate in this work the French administrative territorial divisions known as *sous-préfectures* or *arrondissements*. There were between two and six of them in each department.

demand and a supply-side argument explain this association. First, since families had to pay monthly schooling fees so that their children could go to school, a higher purchasing power was making primary schooling more affordable. Secondly, the municipalities that wanted to invest in primary schools could also do so more easily if they were collecting great amounts of money coming from taxes (Montalbo, 2019a). The high concentration of primary schools and economic resources in the north-eastern part of France exemplifies this relation (Lepetit, 1986), (Grew and Harrigan, 1991). There were, however, some counter-examples, as the relatively poor mountainous area of *Briançonnais* in the Hautes-Alpes department where literacy rates were among the highest in France at the beginning of the nineteenth century. In this case, it seems that poverty and bad weather during the long winter months, making agricultural work harsher, prompted people into becoming teachers in the surrounding areas (Sandre and Ozouf, 1979).

All these factors account partly for the unequal involvement of families and municipalities in primary schooling. Broadly speaking, they point out that in departments with higher economic resources, a more concentrated population and a longer tradition of instruction outside the family sphere, there was a higher probability to find more primary schools and larger enrolment rates. However, they do not indicate how the institutional features of the schooling system itself influenced the presence of schools, enrolment rates and the accumulation of human capital. In this work, I will show that the distinction between private and public primary schooling was essential in explaining the uneven distribution of these three phenomena between municipalities.

To do so, I will use a newly constituted database on education at the level of districts and municipalities. This database is extracted from a national survey launched by French Minister of Education François Guizot in 1833, the very year he made mandatory for any municipality over 500 inhabitants to open and maintain a primary school for boys. The survey, conducted in every primary school of every French municipality, provides very precise information on the characteristics of schools, teachers and municipal investment in education before the implementation of the law. I collected the data at the municipal level for 22 departments, which amounts to 8 129 towns and villages, a primary school being located in 59.5% of them.

Firstly, I exhibit a positive correlation between wealth at the level of districts and municipal investment in primary schools. From the Revolution to the Guizot Law, municipalities were more often investing in schools when they were located in districts with higher economic resources. Therefore, the stable difference between French areas in terms of primary schools concentration at that time actually corresponded greatly to differences in public investment. Secondly, I show that within these public schools, the level of schooling fees was on average lower than in their private counterparts. This level was set freely by teachers if they were not provided with municipal grants (therefore in private schools) but was subject to a negotiation between them and the local authorities when a school was subsidised. Therefore, a lower level demonstrated the will of authorities to decrease the cost of education borne by families in exchange for grants. This contributed to increase enrolment rates as education came at a lower cost for parents. Since

enrolment was not mandatory, this shows that an unsatisfied demand for education also existed within the population of the municipalities at stake. As a consequence, public investment also accounted greatly for the differences in enrolment rates, even after controlling by the level of economic resources.

Thirdly, I identify an association between public primary schooling, teaching conditions and human capital accumulation. Municipalities tended to recruit more qualified teachers for their schools, which resulted in a higher teaching quality, a higher discipline within classrooms and more progress made by pupils. The number of subjects taught in these schools, along with the average number of schooling years, were also higher than in the private ones, indicating that children were learning more. Human capital accumulation, whether proxied by the progress of pupils or by the the number of subjects taught and schooling years, was then higher within public schools. Municipal investment is therefore a crucial factor in explaining the evolution of primary schooling before the Guizot Law. In richer areas where schools were already well-spread before the Revolution, municipalities took over the control of primary education and actively worked on extending it. This accounted for the unequal presence of schools, the variation in enrolment rates and in human capital accumulation.

This paper contributes to the existing literature on education development in several ways. It shows that, if factors external to the schooling system itself as economic resources, military rivalry, democracy, land distribution, ... influenced educational achievements, the institutional characteristics of this system are of prime importance to account for schooling development. In France, economic resources were essential to explain the concentration of primary schools. But the variations in enrolment rates and human capital accumulation can only be fully understood taking into account the difference between public and private primary schooling. This particular feature of the French schooling system explains why, at the same level of resources, some municipalities were characterised by higher educational achievements. At a more aggregated level, this also accounts for the unequal spread of education between French departments. Therefore, looking more deeply at the characteristics of each national schooling system may prove useful in explaining the development of education, either between municipalities, regions or countries.

This paper is organised as follows. Section 2 describes the historical background of primary schooling. Data is introduced in Section 3. Section 4 presents the results for what regards the presence of schools and municipal grants while section 5 deals with the relationship between enrolment rates and the level of schooling fees. Section 6 explores the link between public primary schooling, teaching conditions and human capital accumulation. Section 7 concludes.

2 Historical Background

Before the Guizot Law, local initiatives were determinant in explaining primary schools' presence and characteristics, while national legislation was often absent or ineffective⁷. Indeed, the first "coercing" royal decree on primary education was passed on the 13th of December 1698 under King Louis XIV⁸. It aimed at making primary instruction mandatory but was never really applied. From the end of the 15th century and until the French Revolution, the organisation of primary schools was broadly divided into two models, one in the north and north-east parts of France and the other one characterising rather the southern part of the country. The first one can be described as ecclesiastical or parochial. Teachers were indeed paid with a part of the tithe, as in Lorraine, or directly by the parishioners as in Normandy⁹. Religious foundations were more actively participating to fund primary schools in the north-western area. In each case, teachers were expected to be clerics, assisting parish priests during the mass and to serve as cantor¹⁰. In the south of France, especially in Provence, the organisation of primary schooling was rather municipal. Teachers were recruited by local authorities by means of an annual contract like it was the case with bakers or butchers. A negotiation with the town council permitted to choose teachers' wage, financed by a combination of a tax supplement on the inhabitants of the municipality and by schooling fees, or only by the fees paid by families. Therefore, the school could remain privately financed even if local authorities were involved in choosing the teacher. Most of the times, no religious obligations were expected to be fulfilled as in the northern model. Apart from these two general models, there were also other forms of schooling organisation characterising the small or on the contrary the bigger towns. Parish priests could take over the provision of primary instruction in small localities while in cities like Paris or Rouen, corporations of *maitres-écrivains* were in theory granted with the monopoly of teaching how to read and write¹¹ (Lebrun et al., 2003).

This description of primary schooling mostly applied to boys. Girls were, until the Falloux Law of 1850, left apart from the national legislation on primary schools and not supposed to be taught along with boys. However, it was common to gather both sexes when economic resources were too scarce to create two distinct schools¹². Therefore, until late in the 19th century, numerous religious congregations actually took over the schooling of girls. For example, the *Ursulines* in the south-east, the *Filles de Notre-Dame*, the *Sœurs de la Charité de*

⁷More information on education in France in the 18th and early 19th centuries can be found in (Graff, 1987), which also provides a comparison with other western countries. A comparison with England is provided by (Vaughan and Archer, 1971) while education and state formation in France, England and the USA is studied in (Green, 1990).

⁸Followed by another in 1724.

⁹In both cases, they could also have benefited from *corvée* and *taille* (land tax) exemptions.

¹⁰The influence of religion on education was long-lasting, even at the end of the 19th century. The share of pupils in Catholic schools at the department level was for example not significantly affected by the increase in public spendings on education between 1878 and 1902 (Franck and Johnson, 2016). Therefore, regions where education was associated more closely to religion, especially in Brittany, tended to school their children in religious schools even late into the 19th century.

¹¹This was in practise impossible to apply.

¹²At the time of the passing of the Guizot Law, separated primary schools for girls were still rare. Victor Cousin described them as "almost luxury schools" before the Chamber of Deputies in 1833.

l'instruction chrétienne or the *Filles de la Visitation* within the Parisian region. But for the majority of them, no education was provided outside of the family sphere. The most prominent congregation for boys was the *Frères des écoles chrétiennes* authorised in 1724, mostly present in towns, which provided free education. There were around 1 000 *frères* at the time of the French Revolution, 36 000 pupils being instructed by them.

The revolutionary period and the First Republic (1789-1804) were marked by the suppression of congregations in 1792, but no significant measure on primary education were adopted despite numerous debates in the Assembly led by Talleyrand, Condorcet or Lakanal (Graff, 1987). However, the end of the Old Regime saw the separation between primary schooling and the religious sphere. Indeed, teachers couldn't be paid with a share of ecclesiastical taxes any-more, which had been suppressed. Their wages were from then on to be composed of schooling fees, municipal grants or a combination of both. Public grants could took several forms: paying the teacher annually, providing him with an accommodation, a classroom or another municipal activity. In this last case, the teacher had also to serve as town clerk or mass cantors to benefit from the municipal financial support. This type of investment characterised small towns with low economic resources and a few pupils attending primary schools¹³.

No clear indications on how municipalities should levy funds to finance schools were formulated until the Guizot law (Savoie, 2014). After the passing of this law, they had to finance schooling with a share of their own resources which could come from the four direct contributions created during the revolutionary period¹⁴. They could also make use of resources coming from the *octrois*, which corresponded to indirect taxes on products imported and sold within the delimitations of the municipality¹⁵. Finally, municipalities could also levy additional cents for special purposes, as instruction for example. This consisted in asking taxpayers to pay an additional given amount of cents for any franc of tax. Departments were also contributing to the funding of primary schools but in a very limited proportion. Indeed, it was only after the Guizot law that municipalities had formally the right and the duty to ask for their help when they own resources and the amounts collected through additional cents were too low to finance the schools¹⁶.

The Napoleonic period (1804-1815) saw the creation of the *Université* in 1806-1808 and a

¹³It is true that other shocks affected education in France before the Revolution. The expulsion of the Jesuits in 1763 for example destabilised the educational system. Indeed, the *collèges*, the educational level just after primary schooling, was highly controlled by Jesuit teachers. However, this expulsion didn't really affect primary education. Also, there was no shock on primary schooling funding system comparable to the one of the Revolution which suppressed the financial base over which the primary schools were lying.

¹⁴The *Assemblée Constituante* implemented in 1791 a land tax, a personal property tax on incomes coming from other sources than land and commercial activities and a *patente* tax on these commercial resources. An additional tax on the number of doors and windows of habitations was later implemented in 1798.

¹⁵These *octrois* had been suppressed in 1791 and progressively reintroduced from 1798 onwards. Taxes on beverages were for example re-established in 1804, in 1806 for those on salt. They constituted a crucial source of income for municipalities. For example, in 1913, it is estimated that one-third of the economic resources of provincial towns were coming from these indirect taxes, half of the resources of Paris.

¹⁶The role of the state was even smaller since it is only during the Restoration that the credits dedicated to primary schooling began to rise, from 50 000 francs to 981 000 francs between 1816 and 1832. They were doubled in 1829 and 1830. These credits were essentially employed in buying textbooks intended to be distributed to indigents.

focus on secondary schooling rather than primary education. Along with the preceding period, a lack of financial means prevented national authorities from undertaking important reforms on primary instruction (Mayeur, 2004). The Restoration (1815-1830) was the time period of a stronger implication of authorities. This began by an increase in the funds dedicated to primary schooling. Also, in 1816, a new law created supervising committees at the level of cantons and a certification of morality granted by the mayor and the parish priest. This latter was from then on required to become a teacher. Along with this, a three-level certification of skills was implemented. Teachers were supposed to have at least the lowest one in order to practice. Municipalities were also compelled to provide children with primary instruction, which was also supposed to be free for the indigents. This last measure was actually not applied¹⁷.

The two models of primary schooling which existed before the Revolution in France also corresponded to two unequal spread of schools. From the 16th century onwards, regions north of the Loire river like Alsace or Normandy were well-endowed in primary schools while, in the South-West, only one parish over five had a school. The situation didn't evolve much during the next century. Taking marriage signature as a proxy for literacy¹⁸, only three departments (within their nowadays borders) north of the Saint-Malo/Geneva line exhibited a signature rate for spouses lower than 20% whereas no more than four of them had a higher rate south of this very line. The average national values for women and men were of 14% and 27% at that time. In Figure 1.1, one may see the geographical division of French territory for what regards this signature rate and its stability from the end of the 17th century to the Guizot law of 1833. There has even been a reinforcement of differences in favour of the eastern regions and a relative decline of western ones. This pattern remained stable at least until the 1860s in France, even if a convergence in educational attainment was already at work between departments before the Ferry Laws (Diebolt et al., 2005)¹⁹. The number of children schooled per 10 000 inhabitants, for example, still followed closely the geographical distribution described in the mid-1850s and mid-1860s. The same is true for percentage of women or men signing their marriage license in 1871-1875.²⁰

The objective of this work is not to explain the origin of the St-Malo/Geneva line. Firstly, it

¹⁷A precise description of the daily life of schools and teachers in the eighteenth and early nineteenth centuries can be found in (Duveau, 1957). Analyses or testimonies on the state of primary schooling by teachers from the early nineteenth century are available in (Lorain, 1837) and (Meunier, 1981). In order to have an analysis of local schooling development in the eighteenth century, see for example (Vovelle, 1975) or (Laget, 1971). See (Gildea, 1983) for a local study from 1800 onwards for the departments of Ille-et-Vilaine, Gard and Nord. In order to have a full political analysis and a description of the laws, projects, and debates about primary instruction during the eighteenth and nineteenth centuries, one can refer to (Gontard, 1959) and the second and third chapters in (Furet and Ozouf, 1977b). See (Nique, 1990) to have a description of educational state measures from 1815 onwards.

¹⁸Spouses and their witnesses had to sign marriage register from 1667 onwards. This is why this proxy has been only available since the end of the 17th century.

¹⁹This convergence was most likely due to the fact that municipalities had, after the Guizot law, to fund primary schools through taxation or to ask for a financial assistance to departments. This contributed to increase the supply of schools and the enrolment of children. Similarly, a higher centralisation of primary schooling after the Daneo-Credaro Reform of 1911 in Italy also favoured the development of primary education (Cappelli, 2016b), (Cappelli and Vasta, 2019). In the French case, the centralisation process accentuated during the 19th century until the Ferry laws made schooling free and compulsory.

²⁰See Figure 1.B1 in the Appendix.

must be acknowledged that this simple opposition is too crude to describe the exact state of education at the end of the 18th century, and subject to political influences (Chartier, 1992). Also, many factors inside the departments north or south of the line affected primary schooling expansion. The educational edge of cities over rural areas, for example, is valid in both regions (Furet and Ozouf, 1977a), (Houdaille, 1977) (Graff, 1987). Local studies confirm this pattern. Cities of around 5 000 inhabitants in Provence were characterised by a male literacy rate of 40% in the early 19th century, while this rate varied between 15% and 30% for places of less than 1 000 inhabitants (Vovelle, 1975). This work focuses rather on explaining why the differences between departments remain stable after the shock of the Revolution. Also, thanks to data at the level of municipalities and schools themselves, I investigate the determinants of primary schools' presence and efficiency within the departments at stake. Therefore, I take the St-Malo/Geneva line as a crude starting point and study its stability. By doing so, I exhibit municipal factors influencing primary schooling which are valid within departments. This sheds a new light on the determinants of schooling achievement in nineteenth-century France, either south or north of the line.

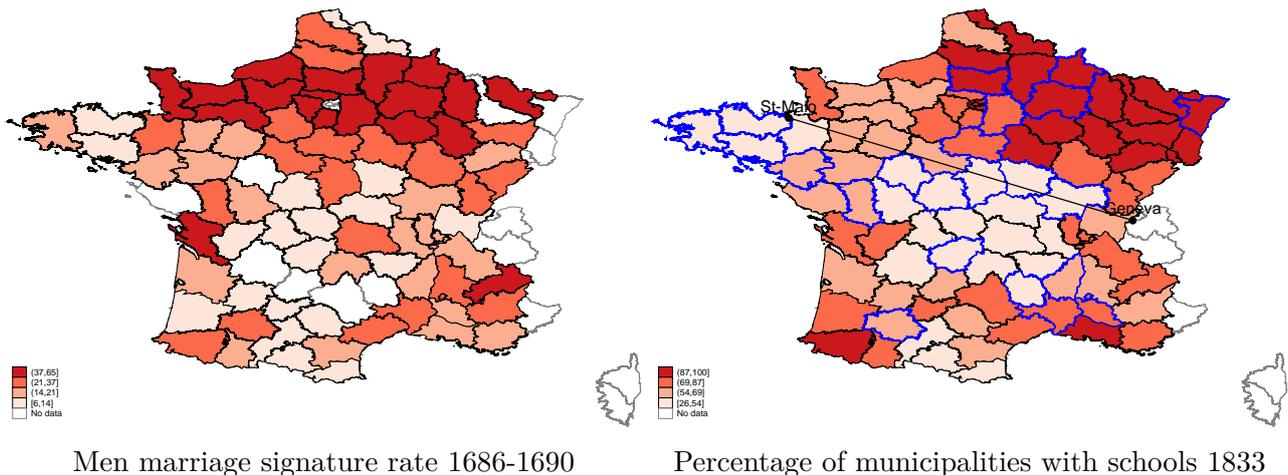


Figure 1.1: Literacy rate and primary schooling

Source: Statistique générale de la France, Guizot survey.

Note: Departments in blue are the ones for which education data are available at the level of municipalities.

3 Data

3.1 Data on Education

The data I use in this work is coming from a national survey conducted in 1833 under the supervision of French Minister of Education François Guizot²¹. 490 inspectors were sent throughout

²¹A lot of information on this survey is available here : <http://www.inrp.fr/she/guizot/>.

France in autumn 1833 to inspect all primary schools, both public and private. However, primary schools to which only girls were attending were excluded from the scope of the survey as the Guizot law didn't apply to them. All departments were inspected, except Corsica²².

Data coming from the Guizot Survey of 1833 was published for all French districts in a *Report to the King* (Guizot, 1834). Only some of the questions asked in the initial survey, those deemed of major interest, were aggregated in this report. From the initial individual (at the level of each primary school) forms, the data was collected for 22 departments and 8 129 municipalities²³. At least one primary school was present in 4 836 of them (59.5%). This project has been initiated by the *Service d'Histoire de l'Éducation* of the I.N.R.P, which collected data for the academies of Nantes, Bourges and Nîmes. Other departments were then added to this initial database. In Figure 1.1, one can see that these departments (in blue) belonged to areas with very different levels of enrolment. The Brittany region and the centre part of France with very low levels of enrolment are well represented in the sample. So are the highly educated north-east and the southern part of the country where education was more unevenly distributed, with five departments for each area. To sum up, around 20% of the departments above the St Malo-Geneva line are represented in the sample, against 25% of those below the line²⁴. This should ensure a high variation in terms of education and a good representativeness of the data used. Their collection was indeed conducted with the aim of catching all the determinants that underpinned primary schools spreading. This, added to the focus at the municipal level, should help avoiding some of the criticisms that were pronounced against the reliance of aggregated historical data on primary schools²⁵. See 72 in the Appendix for a general discussion about the reliability of the data coming from the Guizot survey. Other data on education is coming from the *Statistique générale de la France*²⁶.

The departments selected were quite representative of France for what regards the primary education characteristics that will be under scrutiny in this analysis. Taking average values at the level of districts in order to compare this "municipal level sample" to the entire country thanks to the *Report to the King*²⁷ shows that the investment of municipalities in primary education (provision of a fixed salary or an accommodation to teachers) and the number of primary schools didn't differ significantly between the whole population and the sample. However, enrolment rates and the percentage of municipalities with schools (60.8% against 71.5% for France) were lower in the sample, which means that the departments at stake were less

²²One issue with this data is that only the schools indicated as so by mayors and local authorities were reported by the inspectors. Therefore, it doesn't capture the intensity of familial education or the presence of more informal classes in which a person mastering the basics of literacy was teaching a few children, like the carpenter in (Thabault, 1993).

²³These departments are: Ardèche, Ardennes, Cher, Corrèze, Côtes-du-Nord (Côtes D'Armor), Finistère, Gard, Gers, Indre, Indre-et-Loire, Loire-Inférieure (Loire Atlantique), Loiret, Lozère, Marne, Morbihan, Nièvre, Oise, Bas-Rhin, Saone-et-Loire, Seine-et-Marne, Deux-Sèvres and Vaucluse. At that time, there were 86 departments existing and 26 academies. Current denominations of departments are specified in parenthesis when a change occurred.

²⁴Excluding the three departments located on this very line.

²⁵See for example on this point the criticisms made in (Luc, 1986) and (Luc and Gavaille, 1987). See (Grew and Harrigan, 1986) for a reply and (Furet and Sachs, 1974) for a use of these data.

²⁶These data can be found here <https://journals.openedition.org/acrh/2890>

²⁷See Table 1.A1 in the Appendix.

well-endowed in primary schools than the average national level. This is why several wealth controls along with district and department fixed effects will be introduced in the estimations to reduce potential biases linked to time-invariant specific factors.

3.2 Data on Economic Resources

Data on economic resources is collected from different sources and at different levels of aggregation. For departments, the *Statistique générale de la France* provides data on roads and canals length. Information on taxes is collected from the *Annuaire des contributions directes de l'Empire français* of 1805²⁸. Data on cereal production in 1815 is collected from the *Archives statistiques du Ministère des travaux publics de l'agriculture et du commerce* published in 1837. Wheat prices taken from departmental series established in Labrousse et al. (1970). Other data on agriculture is taken from the national Agricultural Survey of 1852 analysed in (Demonet, 1990). The location of industrial activities and their characteristics come from the Industrial survey conducted between 1839 and 1847 and presented in (Chanut et al., 2000). Finally, data on life expectancy is provided in (Bonneuil, 1997).

3.3 Demographic Data on Municipalities and Districts

Data on the population (total and the number of children and single people) of municipalities and departments is taken from the *Statistique générale de la France*, along with religious presence measured by the number of presbyteries. Population dispersion is taken from the Postal Survey of 1847, along with the surface area of municipalities which have disappeared or merged since 1833²⁹. The *Institut national de l'information géographique et forestière*, a public organism in charge of the diffusion of geographic information in France, provides this data for the other municipalities. The altitude of municipalities is also taken from this organism.

3.4 Descriptive Statistics

Data at the primary school or municipality level is displayed in Table 1.1. Primary schools were located in 59% of the municipalities and 39% of them were paying teachers a fixed annual salary. Around 30% of them were providing teachers with an accommodation or a classroom. These figures were higher at the school level since in 58%, 47% and 55% of the primary schools, a teacher was provided with such municipal grants respectively. Some municipalities were therefore subsidising more than one primary school. This was only the case in bigger towns which had the financial capacities to enhance primary schooling. The average schooling fees paid each month by families amounted to around 1 franc.

At the level of districts, and therefore for the entire country, the average percentage of municipalities with at least one primary school was around 69% in 1833. However, this measure varied

²⁸This statistical directory provides data about the "quatre vieilles" direct taxes implemented in France after the Revolution.

²⁹More information on this survey is available in (Marin and Marraud, 2011).

a lot since some districts had less than 20% of their municipalities endowed with schools. It is not possible to know the percentage of public schools as this information was not aggregated. However, there were around 57 public schools per 100 municipalities on average within each district. Once again, some districts were characterised by a very low schooling investment of municipalities, with less than 5 subsidised schools for 100³⁰.

Table 1.1: Education Summary Statistics - Municipal and school levels

Variable	Mean	Std. Dev.	Min.	Max.	N
Primary schools level					
Average schooling fees (data)	96	60	8	600	2420
Average schooling fees (computed)	113	69	6	795	4092
Fixed salary	0.58		0	1	6380
Salary amount - Only when paid (francs per year)	255.99	236.72	2	3000	3737
Salary amount	148.31	221.32	0	3000	6292
Accommodation	0.47		0	1	5742
Classroom	0.55		0	1	5742
Other municipal occupation	0.47		0	1	6328
Other municipal occupation salary amount - Only when paid	101.69	108.85	1	900	2695
Other municipal occupation salary amount	45.46	88.65	0	900	6014
Number of subjects	4.76	1.62	1	11	5715
Schooling years	4.99	1.93	1	9	5678
Municipality level					
Primary school	0.59		0	1	8129
Fixed salary	0.39		0	1	8129
Salary amount	97.09	184.38	0	2400	8129
Accommodation	0.29		0	1	8129
Classroom	0.33		0	1	8129
Other municipal occupation	0.58		0	1	4651
Other municipal occupation salary amount	30.42	74.11	0	900	8129
Pupils per 100 inhabitants - Winter	9.49	6.79	0.27	61.64	4658

Source: Guizot survey.

Notes: Schooling fees are in cents of francs. In 58% of the primary schools, the teachers were provided with a fixed salary. In 39% of municipalities, there existed a primary schools providing a fixed salary to a teacher. The average fixed salary granted was of 259 francs per year, taking into account only the teachers paid so. This average value was of 97 francs when taking the mean of the average salary at the municipality level, meaning that, on average, municipalities were each paying teachers 97 francs annually. In the data, there are observations for which only the minimum and maximum fees paid by parents is specified. I took the mean of these two values to add observations to the average schooling fees. This measure corresponds to the "computed" average schooling fees in the table.

³⁰See Table 1.A2 in the Appendix.

4 Municipal Investment in Primary Schooling

In this section, I exhibit a positive correlation between economic resources and public investment in primary schooling. To do so, I use data on the heights of military conscripts to approximate the level of economic resources. Indeed, other economic indicators for this time period are either only available at the department level (as agricultural production for example) or too concentrated in some areas to fully account for the economic resources of districts (as the industrial characteristics). In France, since the Jourdan-Delbrel law of 1798, all single French men had to accomplish a compulsory military service between 20 and 25 years old. In 1804, Napoléon instituted a random draw to select the conscripts. Therefore, there is no selection bias with these data as each young men had the same probability to serve³¹. On top of that, at the end of the 19th century, the height of conscripts drew away from the normal distribution only in a small number of departments³² (Bassino and Dormois, 2009)³³.

Data on the height, collected at the level of districts for the 1818-1830 time period on 489 160 twenty years old conscripts (that is to say on men born between 1798 and 1810) is presented and analysed in (Aron et al., 1972). The average height was clearly mirroring the economic development of France. This is in line with other studies exhibiting strong correlations between height, living and health conditions, work at young ages, nutritional intake, ... during the 17th and 18th centuries (Komlos et al., 2003), the 19th century (Villermé, 1829), at the end of this former and during the following (Chamla, 1964), (Meerten, 1990), (Brinkman et al., 1988)³⁴.

For the present study, I select the percentage of young men whose height was above 1.679 meters and call this measure "the percentage of high heights among conscripts". The average height was around 1.65 meters for the whole sample. However, since this measure was reported by intervals in the original data, I select as "tall" the conscripts present from the interval next to the one where the average height lied³⁵. Comparing data on conscripts to the economic indicators available at the department level tends to confirm that the percentage of high heights can be used as a fairly good proxy for economic resources. There was indeed a positive correlation between this measure and life expectancy, the production of cereals per hectare and the amount

³¹There still existed some ways to avoid entering the army since wealthy enough people could pay a substitute for their sons by means of a contract before notary. Moreover, some conscripts were still volunteers. However, as this represented only a small part of the total conscripts, it should not lead to a bias in the quality of average height as a proxy for economic resources.

³²None of these departments are part of the ones for which data on education has been collected at the primary school and municipal levels.

³³What could be important is also to control for the fact that some conscripts may have enrolled in districts different from the ones where they were born in. However, migrations at the beginning of the nineteenth century were on average 35 kilometres long (Heffernan, 1989), mostly concentrated below 55 kilometres even at the end of the century (Rosental et al., 2000), (Rosental, 2004). Therefore, it is very unlikely that a sufficient number of young men would have migrated to a department differing greatly in terms of economic resources to bias the measure.

³⁴See (Steckel, 1995) for a review of the literature on this point.

³⁵Height intervals, the histogram of the percentage of high heights and the geographical repartition of high conscripts are reported in Figure 1.B2 in the Appendix. The percentage of high heights varied between 13% ad 56% with a mean of 32%. There was a quite strong symmetry between the map of high heights and the distribution of marriage signatures and municipalities with schools (Aron et al., 1972), (Ladurie et al., 1976), (Ladurie and Demonet, 1980).

of taxes on doors and windows per capita at the beginning of the nineteenth century. Height was on the contrary negatively correlated with mortality rate between 0-5 years old and the price of wheat per hectolitre³⁶.

Descriptively, the percentage of high heights among military conscripts correlates positively with the aggregated data on education at the district level³⁷.

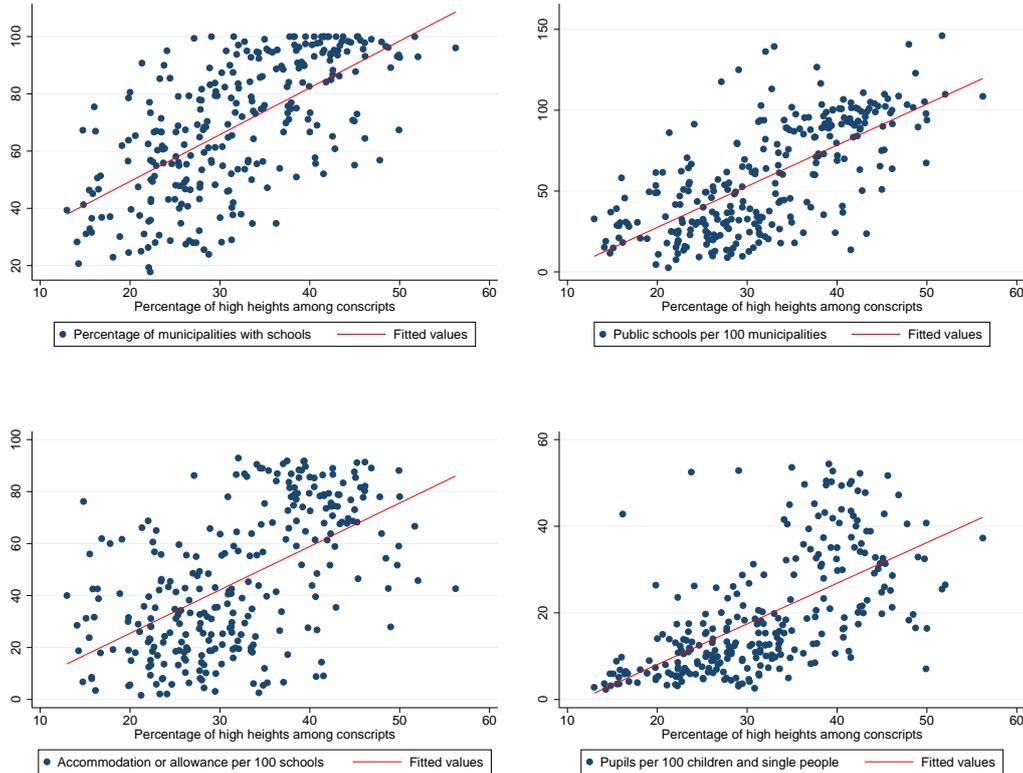


Figure 1.2: High heights among conscripts and primary schooling

Source: Guizot Survey and military data on conscripts from (Aron et al., 1972).

Figure 1.2 plots the relationship between this percentage and the ratio of municipalities with primary schools, the number of public schools per 100 municipalities, the number of teachers benefiting from an accommodation or accommodation allowance from municipalities and the number of children attending schools per 100 children and single people. The correlations are all positive and significant³⁸. Therefore, districts in which the standards of living were higher were also characterised by high enrolment rates and a strong concentration of primary schools and municipal grants.

³⁶This price is taken as measure of food cost. See Figure 1.B4 in the Appendix.

³⁷The geographical patterns of high heights and municipal investment in primary schooling indicators are displayed in Figure 1.B3 in the Appendix. They illustrate the correspondence at the department level between these two phenomena.

³⁸Their magnitudes are respectively of 0.64, 0.69, 0.56 and 0.62, all significant at a one-percent level.

In order to evaluate this relation, I use the following simple OLS framework :

$$Schooling_{arr,d} = \alpha_{arr} + \beta_1 Height_{arr,d} + \beta_2 Ind_{arr,d} + \beta_3 Demo_{arr,d} + \beta_4 Eco_d + \epsilon_{arr,d} \quad (1)$$

where *Schooling* stands for primary schooling variables at the level of the district *arr* and department *d*. *Height* represents the percentage of high heights among military conscripts, *Ind* stands for industrial controls, *Demo* for demographical and geographical controls and *Eco* for economic controls at the department level³⁹. Standard errors indexed by *d* are clustered at the department level. This is done in order to account for spatial correlation within them. Indeed, as some control variables are defined at a more aggregated level than districts, not doing so could cause standard errors to be seriously downward-biased and lead to spurious findings. This may happen for example if the micro units (the districts) share some unobservable characteristics in a given group (departments) (Moulton, 1986), (Moulton, 1990). For example, the long-term effect of Protestant settlement and the use of a patois were identified in the literature as having influenced schooling spread⁴⁰.

For what regards demographic and geographic variables, I control by the average altitude of municipalities within each district, their surface area, their total population in 1831 and by the share of their population that is considered to have been scattered. This last measure is coming from the postal survey and based on a simple contiguity criterion. It is expected to have influenced negatively primary schooling by increasing the distance from habitations to schools and therefore decreasing the number of pupils. Mountainous land is expected to have had the same effect. Population should, on the contrary, have increased the potential number of pupils and the resources municipalities could dedicate to education. I also add the number of single people and children in 1831 in each department as a control. Surface area's effect is *a priori* less clear since it could have at the same increase distances from school and the amount of agricultural resources available. Finally, I also control by the fact that the prefecture is located in the district at stake.

Economic controls at the district level are: the ratio of municipalities with industrial activities, the number of workers and engines in industry along with the value of industrial production. The amount of agricultural land is also controlled for. Finally, at the level of departments, I also control by the length of roads and water communications, the price of wheat in 1799, the amount of taxes on doors and windows per capita in 1836, the production of cereals per hectare in 1815 and life expectancy at birth in 1806-1810. These economic controls are complemented by the number of presbyteries used as a proxy for religious influence.

³⁹See the description of data in the Appendix to have a full list of the controls used in the estimations.

⁴⁰Indeed the effects of the Reform and Counter-Reform were found to have had a positive effect on schools. See for example (Laget, 1971) in the case of Bas-Languedoc. Moreover, at the beginning of the nineteenth century, the strong presence of a patois was identified by social observers as a barrier to the spread of instruction. Evidence seems to comfort this point of view as, for example, in the case of Morbihan, the fact of speaking Breton compared to French was correlated with a lower literacy rate, for any kinds of profession (Furet and Ozouf, 1977b).

Results are displayed in Table 1.2. The presence of primary schools as well as the public investment in instruction were negatively influenced by population dispersion and positively by the presence of industrial factories which can be taken as a sign of economic dynamism. Population dispersion is the only demographic or geographic variable remaining significant across the specifications. This is in line with the importance attributed to the effect of this variable on education in historical case studies (Furet and Ozouf, 1977b). All the coefficients associated to the percentage of high heights among conscripts are positive and significant. Given that this percentage had a standard deviation of 9, one standard deviation increase implied a rise of around 6.7 in the percentage of municipalities with schools within the districts. The effect was of the same magnitude for the number of public school per 100 municipalities. When decomposing this latter, it appears that the magnitude was slightly higher for what regards providing teachers with an accommodation or an allowance than for paying them on a regular annual basis. This was certainly due to the fact that municipalities could more easily find an empty house for their teachers than the funds necessary to pay them during a whole year. Therefore, economic resources tended to be associated with a higher total number of schools, a higher percentage of municipalities with schools and municipal investment in education. The same was true for enrolment rates⁴¹. Since there is no data on the number of children per district before the mid-nineteenth century, I take the number of children and single people as the denominator in the enrolment rate measure. This assumes the repartition between children and single people to have been equivalent between districts, which seems to be a fairly reasonable assumption. One standard deviation increase in the heights of conscripts was associated to a 3.3 increase in the number of pupils schooled⁴².

⁴¹Pupils attending schools in winter are taken into account in this enrolment measure. This is done in order to avoid letting aside all children performing agricultural tasks in summertime. Taking winter numbers therefore prevents from downplaying the importance of primary schooling in agricultural districts.

⁴²In Table 1.A3 in the Appendix, I compute and report standardised beta coefficients. One standard deviation increase in conscripts' high height has a stronger effect on the percentage of municipalities with schools, 0.27, and on enrolment rates, 0.26. The respective figures for the number of schools and of public schools are 0.24 and 0.21. Accommodation are indeed more often provided to teachers than a fixed salary when resources are increasing, with magnitude of around 0.18 standard deviation against 0.16 for the fixed salary grant.

Table 1.2: Heights of conscripts and primary schooling

	(1)	(2)	(3)	(4)	(5)	(6)
	Percentage of municipalities with primary schools	Primary schools per 100 municipalities	Public schools per 100 municipalities	Accommodation or allowance per 100 schools	Paid teachers per 100 schools	Enrolment
High heights among conscripts	0.682*** (3.292)	0.874** (2.174)	0.759*** (2.922)	0.523* (1.724)	0.499* (1.979)	0.366*** (3.101)
Population dispersion	-0.388*** (-5.658)	-0.527*** (-4.890)	-0.655*** (-6.356)	-0.338*** (-3.935)	-0.511*** (-6.372)	-0.126*** (-2.782)
Factories' presence	0.288*** (2.813)	0.467*** (2.770)	0.565*** (4.028)	0.221 (1.632)	0.154 (0.988)	-0.046 (-0.780)
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
Department clusters	81	80	81	81	81	81
Observations	268	264	270	268	264	267
R^2	0.563	0.505	0.701	0.592	0.596	0.689

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *High heights among conscripts* refers to the percentage of conscripts in each district taller than national mean. *Population dispersion* is the percentage of population which was reported scattered in the Postal Survey, based on a contiguity criterion (Roncayolo, 1987). *Factories' presence* is the percentage of municipalities in which at least one factory more than ten workers was located. The *enrolment* rate is defined as the number of children attending schools in winter per 100 children and single people.

The outcomes are robust to the control for Protestant influence. Indeed, one may fear that, as in the Prussian case, a high share of Protestants would positively influence the presence of schools and enrolment rates (Becker and Woessmann, 2009), (Becker and Woessmann, 2010). The same phenomenon has been identified in the Provence region in France (Vovelle, 1975). Including this share at the department level in the estimations doesn't modify the outcomes' significance and doesn't affect greatly their magnitude⁴³. The percentage of Protestants is taken from the 1861 census as it is not measured in the previous waves. Its average value between departments was around 2.19%. However, it is only in seven departments that this percentage was higher than 10% in 1861, namely in Ardèche, Doubs, Drôme, Gard, Lozère, Bas-Rhin and Deux-Sèvres.

Taking another measure of height as a robustness check, the number of young men that were examined but deemed too small (below 1.57 meters) for the conscription doesn't change the results either⁴⁴. Thanks to the Guizot survey, I can also take as a dependent variable the public investment at the level of municipalities and not districts. Descriptively, the proportion of municipalities with at least one primary school was higher in districts where the proportion of high heights was high too. This was also the case with any type of municipal investment

⁴³See Table 1.A4 in the Appendix.

⁴⁴See Table 1.A5 in the Appendix. The results are all negative and significant with respect to the same dependent variables that were under scrutiny in the previous table, except when public schools are decomposed between teachers with a salary and teachers with an accommodation. This is certainly due to the fact that I don't have the percentage of teachers paid or provided with an accommodation at the level of districts. Since more primary schools existed in the areas where public investment was high, this entails that decomposing this investment between its different components may reduce the number of observations too much to induce a significant difference with districts where public investment was low.

and the wages provided to teachers⁴⁵. The relation is confirmed by the use of OLS estimations, displayed in Table 1.A6 in the Appendix. Whether using department wealth controls or department fixed effects, the results remain positive and significant. This is true for any type of investment: paying teachers a fixed salary (and its amount), providing them with an accommodation, a classroom, another municipal occupation (and its salary amount).

Public investment was also higher in wealthier districts when focusing on schoolhouses. Estimations outcomes in Table 1.A7 in the Appendix indicate that the percentage of municipalities with a sufficient number of schoolhouses was higher in districts well-endowed in economic resources, and where population dispersion was lower. They also indicate that the total number of schoolhouses was higher in such districts, along with the number of schoolhouses owned by municipalities. The effect on the number rented was positive but not significant. Erecting a building only dedicated to primary instruction demonstrated a great involvement of municipalities. Indeed, in half of the districts, less than one-third of all municipalities were deemed as endowed with a sufficient number of schoolhouses in the survey.

This section was not intended to prove the causal impact of economic resources on primary schools. However, it did demonstrate that, after the Revolution, the districts well-endowed in economic resources were also characterised by a high concentration of schools, a higher proportion of public schools and greater enrolment rates. Moreover, as shown in Figure 1.1, the geographical pattern of education remained quite stable from the Revolution to the Guizot law. Therefore, municipalities with a longer educational tradition took over the control of primary instruction and substituted their own resources to the religious taxes that were previously financing the schools. They were able to do so since these municipalities were also endowed with higher economic resources after the Revolution. In districts and municipalities where resources were scarcer and education previously less developed, primary schools remained generally private, financed only by fees, and were characterised by low enrolment rates. Municipalities in richer areas could also have left education to be financed this way, as families had a higher purchasing power there and could more easily pay the schooling fees. However, they did not so, and this is an important point. Indeed, they didn't only substitute a public supply of schools to the previous religious one. Municipalities also acted vigorously to increase enrolment rates and improve teaching conditions and the accumulation of human capital.

5 Lower Schooling Fees Level and Higher Enrolment Rates in Public Primary Schools

5.1 Descriptive Statistics

Over the 22 departments in the database, only 2.8% of the schools were totally free for families. Paying schooling fees was therefore part and parcel of primary instruction, even when the school was provided with municipal investment. These fees were paid monthly to teachers.

⁴⁵See Figure 1.B5 in the Appendix.

Their level depended on the number of subjects learned and, therefore, often on the age of the pupil. Indeed, education was thought in a more linear way than nowadays. Children were first learning how to read, then how to write, then the basics of numeracy and so on (Mayeur, 2004)⁴⁶. If the teacher was depending only on schooling fees to make a living, then he could fix their level as he intended to. However, when he was provided with municipal grants, this level was subject to a negotiation between the teacher and local authorities.

These fees could constitute a high cost for families who wanted their children to attend primary schools. The minimum level to learn only how to read was often set between 50 and 75 cents of francs. Learning the arithmetic costed typically between 1.5 and 1.75 francs. Pupils learning history, geography, linear drawing, land surveying or music had to pay more⁴⁷. On average, paying the schooling fees for one child amounted to spend between 1 and 1.2 francs per month⁴⁸. This was equivalent to the daily wage of an industrial female worker, between 50% and 71% of an industrial male daily wage. The agricultural survey of 1852 indicates the annual spendings and savings of a day-worker family with three children⁴⁹. Assuming that one of them was working and, depending on the hypotheses made on the attendance of the two children left (both 12 months, one 12 and the other 6 or both 6 months) schooling fees represented respectively 16, 21 or 26% of total savings. The fees were therefore a strong economic barrier to the schooling of children coming from destitute backgrounds⁵⁰. The high pressure of fees in the French case has notably been described as a key factor explaining a lower schooling achievement compared to Prussia during the 19th century (Maynes, 1979).

Then, one could expect schooling fees to have been higher in richer areas, where families had a greater purchasing power and where children were learning more. However, in Figure 1.3, the geographical distribution of fees appears to have been the opposite to the one of primary schools and enrolment rates. Indeed, fees were higher south of the Saint-Malo/Geneva line, especially in the Gironde region and in the Mediterranean area. Their level correlated therefore negatively with the percentage of high height among conscripts within districts. Areas more endowed in schools and economic resources were also those where the fees were the lowest.

This was also true at the level of primary schools themselves. Since the number of children at the municipal level is not available for the time period under scrutiny, I report here as an enrolment rate the number of pupils per 100 inhabitants. I divide municipalities into quarters depending on their population in order to have similar towns in terms of population age structure. As displayed in Figure 1.4, the higher the fees were in a school, the lower the enrolment rate. This

⁴⁶Part of the fees could be paid in kind, which is hard to take into account and is a limit to the reliability of the data used. Loafs of bread, for example, could serve as a complement to payments in money (Furet and Ozouf, 1977b).

⁴⁷These were the subjects which could be taught in primary schools along with literacy, numeracy and religious instruction. Only a few children were actually studying them.

⁴⁸See Table 1.A8 in the Appendix.

⁴⁹Those were clearly the poorest among agricultural workers since, for example, food represented between 57 and 79% of their annual spendings, with a mean of 66%.

⁵⁰Wages, either in agriculture or industry, were varying between departments in early nineteenth-century France. They were more than two time higher in Ile-de-France for example compared to Brittany (Chanut et al., 1995). Schooling fees were therefore certainly a lower burden on families' budget in the eastern part of the country where wages were the highest.

was especially true for the first three population quarters. Therefore, there seems to have been a link between economic resources, municipal investment in schools, lower schooling fees and higher enrolment rates.

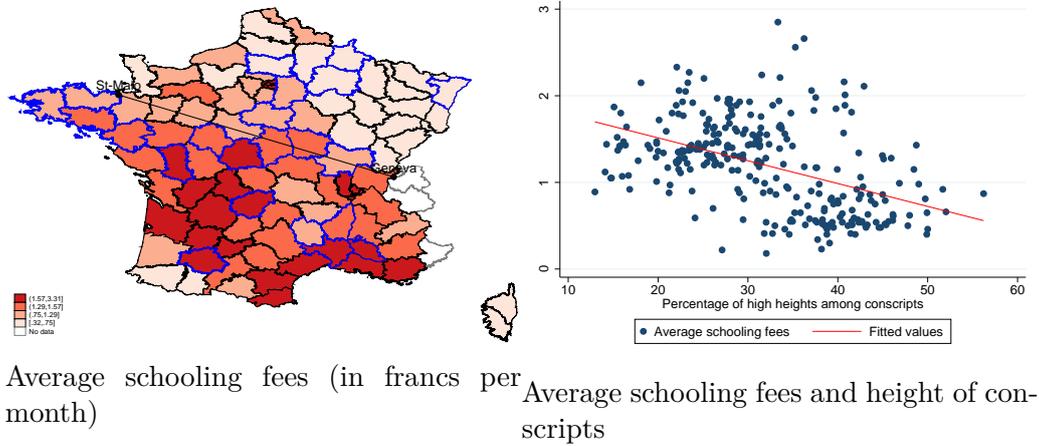


Figure 1.3: Distribution of schooling fees

Source: *Statistique générale de la France*, Guizot survey, military data on conscripts from (Aron et al., 1972).
 Note: Departments in blue are the ones for which education data are available at the level of municipalities.

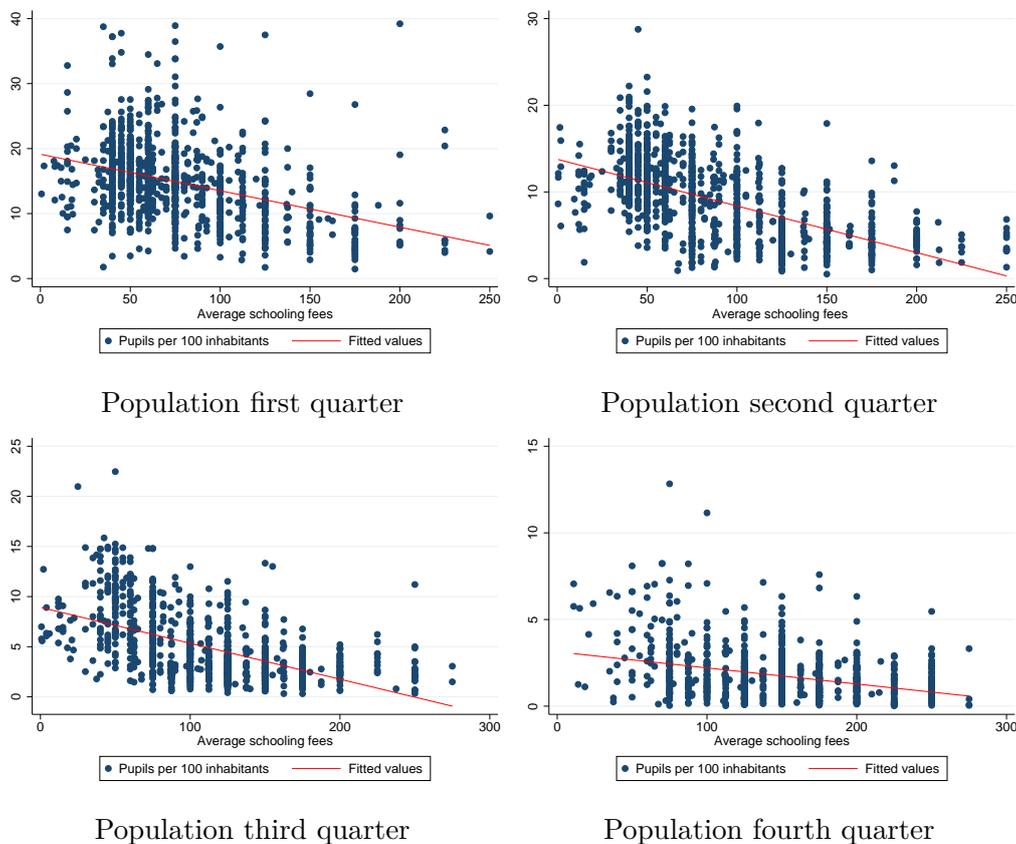


Figure 1.4: Average schooling fees (cents of franc) and enrolment. Primary school level

Source: Guizot survey.

5.2 A Municipal Will to Lower Schooling Fees

This relation is verified by OLS estimations, both at the level of districts and of primary schools. When more public schools were present in a district, fees were on average lower. The effect was especially strong when the municipal investment consisted in paying teachers⁵¹. The advantage of using data at the level of primary schools is to have a direct measure of municipal investment and schooling fees. Also, I can control by several other variables only reported at this level which could have influenced the fees. This gives more reliability to the estimations. Therefore, I add to the controls used so far⁵² the number of subjects taught, the fact of welcoming girls, if the school was a boarding one, the average admission age and length of schooling, the fact of having books in sufficient number, the number of persons at charge for the teacher and his level of certification. Indeed, the fees could have been higher if many pupils were learning several subjects and therefore staying at school for a longer period of time. By the same token, parents had to pay more if children were boarders or if schools were well-endowed in teaching materials. At last, if the teacher was more qualified or if more persons were at his charge, he was more likely to ask for higher fees.

In Table 1.3, I regress the level of schooling fees on a set of binary variables indicating if the teacher was provided with municipal grants in the primary school at stake. Therefore, each coefficient corresponds to the estimation outcome of a regression. The difference between the second and the third column is that I only take the average fees reported in the data in the third one. In the second one, I add to them an average value of fees computed as the mean between the maximum and the minimum values paid by parents when they were specified in the data but that the average value was not. This is due to the fact that inspectors reported in many cases only the minimum level of fees, that is to say the one paid by pupils only learning religious instruction and how to read, and the maximum level paid by those learning several subjects. They didn't make an estimation of the average level of fees at the level of the school⁵³. I complement the data in order to have more observations at the primary school level. This issue also exemplifies the importance of controlling by the average number of schooling years and by the number of subjects taught. Indeed, if more pupils were learning several subjects, the level of fees might have been high because of this composition effect but not because of an active will of teachers or municipal authorities to set a high price for schooling. Therefore, estimations at the primary schools level are much more reliable than between districts as they control for this composition effect affecting the level of fees.

The impact of municipal investment is always negative, contributing to a reduction in the fees

⁵¹See Table 1.A9 in the Appendix.

⁵²Demographic, geographic and industrial variables are available at the level of municipalities. Only agricultural area is still included at the level of districts. Literacy rates of men and women in 1686-1690 are also taken into account in order to control for any effect of the long term educational tradition on schooling fees and enrolment rates in 1833.

⁵³Doing this computation, I have to assume that the mean value between the minimum and maximum values of fees is representative of the average level of fees paid by families. I also tried to take the computed average value as the addition to the minimum one of the average spread between the minimum and the maximum values when reported. This didn't change the results, which are available upon request.

paid. The magnitude of the effect is between 12 and 13 cents of francs, while the average value of fees was around 1 franc per month. Therefore, on average, the mean level of fees in a school publicly subsidised was around 10% lower than in its private counterparts. When decomposing between the different types of subsidies, I find that providing teachers with a salary or a classroom had a higher effect than providing them with an accommodation. Since being paid annually was synonymous with financial ease, this doesn't come as a surprise. Teachers were certainly more willing to decrease fees when they were ensured with being paid on a regular basis. A standard deviation in the salary paid by municipalities was implying a 7 cents decrease of the level of fees. The higher magnitude of the effect without decomposing municipal investment through its different types is due to the fact that, in around 50% of the cases when a school was subsidised, at least two types of grants were provided to teachers, the three of them in 44.5% of the public schools. Municipalities investing in education often did so intensively, using different types of financial support.

The negative effect on the maximum and minimum levels of fees are also interesting. The latter level was the schooling cost of education parents had to pay so that their children could enter the school⁵⁴. Therefore, in schools with municipal investment, the cost of education for most of the families was actually reduced by around 13%. The negative impact on the maximum level, mostly associated to the provision of a fixed salary and its amount, also indicates that the education cost was reduced even for pupils learning the highest number of subjects within the school. The lowering of fees within public primary schools was therefore generalised for all pupils. A direct consequence is that children were more likely to learn more within these schools than within their private counterparts since the cost of learning several subjects (and not only that of entering the school) was reduced. This point is studied in Section 6.

All these estimations show an association between municipal investment and low schooling fees. As said before, there was a negotiation on their amount if municipalities were financing primary schools (Furet and Ozouf, 1977b). When they did so, teachers were less dependent on fees to make a living since part of their expenses or salary was provided by the economic resources of the municipality. This higher financial ease and stability explains why they accepted to lower the level of fees.

⁵⁴It is not possible to know exactly the proportion of pupils paying only this minimum level. However, the proximity between this latter, 90 cents of francs, and the average level of fees, 96 cents, indicate clearly that many of the children actually learnt only religious principles and how to read and write at school.

Table 1.3: Schooling subsidies and schooling fees - Primary school level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Minimum schooling fees	Computed average schooling fees	Average schooling fees	Maximum schooling fees	Minimum schooling fees	Computed average schooling fees	Average schooling fees	Maximum schooling fees
Fixed salary	-9.485*** (-3.699)	-7.330** (-2.258)	-5.448* (-1.717)	-11.213*** (-2.676)	-9.102*** (-4.156)	-6.146** (-2.023)	-4.079 (-1.267)	-16.821*** (-2.598)
Observations	1703	1460	976	1619	2018	1468	964	1647
R^2	0.517	0.636	0.665	0.554	0.573	0.658	0.686	0.587
Fixed salary amount	-0.037*** (-3.588)	-0.035*** (-2.819)	-0.032** (-2.487)	-0.051*** (-3.009)	-0.024*** (-2.860)	-0.034*** (-3.039)	-0.028** (-2.162)	-0.052*** (-3.227)
Observations	1690	1452	971	1610	1978	1459	959	1637
R^2	0.516	0.639	0.669	0.557	0.565	0.661	0.690	0.588
Accommodation	-5.277* (-1.968)	-5.110 (-1.569)	-7.543** (-2.187)	-1.935 (-0.409)	-6.694*** (-2.812)	-6.551** (-2.163)	-7.978** (-2.236)	-6.098 (-1.451)
Observations	1409	1183	799	1316	1718	1190	786	1342
R^2	0.495	0.627	0.667	0.538	0.564	0.650	0.689	0.569
Classroom	-7.217** (-2.641)	-7.814** (-2.248)	-9.832** (-2.398)	-4.328 (-0.840)	-8.124*** (-3.242)	-7.237** (-2.149)	-9.892** (-2.330)	-6.808 (-1.370)
Observations	1409	1183	799	1316	1718	1190	786	1342
R^2	0.497	0.629	0.669	0.539	0.565	0.650	0.690	0.569
Subsidised school	-12.127*** (-2.770)	-12.268** (-2.413)	-13.920** (-2.311)	-14.161** (-2.129)	-12.281*** (-2.785)	-9.412* (-1.830)	-14.292** (-2.372)	-11.582* (-1.780)
Observations	1674	1433	963	1582	1992	1443	952	1611
R^2	0.516	0.635	0.669	0.554	0.573	0.658	0.692	0.585
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	No	No	No	No
Department fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
District clusters	61	57	44	59	69	65	47	67

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

In columns (5) to (8), I run the same estimations including department fixed effects so that the effect of public subsidies is measured using within-departments variation only. As the level of public investment was highly varying between them, this enables to control by economic or social factors specific to a department which might have influenced public investment, the presence of schools and schooling fees. The significance of the outcomes is only slightly modified by this adjustment. Therefore, either in department well-endowed in primary schools or where education achievement was low, public subsidies were associated with a fall in the cost of education parents had to bear. To go further on this point, I also ran the same estimations separating departments into two subsamples, one above the St-Malo/Genave line and one below⁵⁵. The results below the line are quite comparable to the general case. Their magnitude is higher above the line, which tends to show that municipalities in this area could afford to subsidised more education and therefore negotiate an even lower schooling cost⁵⁶. These estimations are robust to the control for spatial autocorrelation in the error term. I computed Conley standard errors (Conley, 1999) based on four different radii of 25, 50, 75 and 100 kilometres following the methodology used in (Ashraf and Galor, 2011). Subsidised primary schools remain negatively and significantly associated with the level of schooling fees⁵⁷.

⁵⁵Departments above the St-Malo/Geneva line are the following: Ardennes, Marne, Seine et Marne, Oise, Loiret, Bas-Rhin, Saône et Loire, Nièvre and Cher.

⁵⁶See Table 1.A10 in the Appendix.

⁵⁷See Table 1.A11 in the Appendix.

5.3 Lower Fees, Higher Enrolment

The lower level of fees in public primary schools was associated with higher enrolment rates. Municipalities didn't invest in schools only to ensure the stability of teachers' presence, but also to increase enrolment. Indeed, a response to the investment of municipalities was that teachers had to welcome freely indigent children chosen by local authorities. They were arbitrarily listed by municipalities and teachers had no means to refuse these pupils⁵⁸. On average, in 1833, 21% of the pupils were welcomed freely. This percentage amounted to 23.6% in public schools and to 10.7% in their private counterparts. Therefore, in exchange for a higher stability in their occupation, teachers were accepting to lower the level of fees and to welcome more pupils, who were either paying less or were attending primary schools freely.

At the level of districts, and therefore for the entire country, an increase in the average fees paid was clearly associated with a fall in enrolment, as displayed in Table 1.4. In all these estimations, I control by the number of pupils freely attending schools so that the effect on enrolment rates is coming from families paying fees. I also control by the total number of schools within districts and by the percentage of municipalities with schools since they were associated to a higher enrolment without any link with the average level of fees. In columns (2) and (4), I also control by the ratio of public schools within districts. In districts where municipal investment in education was high, schooling fees were lower, which contributed to widen the number of pupils attending schools. A standard deviation increase of 50 cents of francs in the average level of fees was entailing a reduction in enrolment between 2.2 and 4.3 pupils per 100 children and single people. Given that the average enrolment rate was of 19, this implied a reduction between 11% and 22% of the enrolment rate for one standard deviation in the average schooling fees⁵⁹.

⁵⁸These lists were sometimes contested since some families were putting pressure on local authorities so that their children would be counted as indigents and could attend schools freely. Indeed, as there were often, for example in small and poor municipalities, more indigent children than one teacher could deal with, most of them were actually not provided with free education. The criteria according to which children were listed or not remain obscure and there was no clearly-defined process to select between them those who would be educated freely.

⁵⁹In order to investigate the robustness of these estimations, I made use of the 1851 Census which reports the number of children by age in each department. Thanks to it, I can have an approximation of the number of children in each district and I don't have to rely on the number of children and single people to measure enrolment rates. The results were not affected by this modification. The effect of the average level of fees on enrolment remained negative and significant, with a slightly higher order of magnitude. See Table 1.A12 in the Appendix. Controlling for Protestant influence doesn't modify the outcomes either. Results available upon request.

Table 1.4: Schooling fees and enrolment rates - District level

	Pupils per 100 children and single people			
	(1)	(2)	(3)	(4)
Average schooling fees	-7.564*** (-6.170)	-5.519*** (-3.948)	-4.339*** (-3.208)	-3.958*** (-2.674)
Total number of schools	0.086*** (3.125)	0.096*** (3.551)	0.067*** (2.908)	0.070*** (3.065)
Percentage of municipalities with schools	0.138*** (4.109)	0.136*** (4.025)	0.144*** (4.253)	0.141*** (4.119)
Free pupils	-0.001 (-0.928)	-0.002 (-1.272)	0.001 (1.444)	0.001 (1.347)
Demographical and geographical controls	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes
Ratio of public schools	No	Yes	No	Yes
Department wealth controls	No	No	Yes	Yes
Department clusters	81	81	74	74
Observations	265	265	244	244
R^2	0.788	0.793	0.864	0.864

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Average schooling fees are defined in francs. Free pupils correspond to the total number of pupils freely welcomed in primary schools within each district.

As before, the use of more disaggregated data is useful in specifying this relation. In Table 1.5, I study enrolment rates at the municipality level, controlling by the same factors as in Table 1.3 and adding the number of free pupils. The measure of fees used in the estimations is the computed level of average fees. However, the issue remains that I don't know the number of children at the level of municipalities. To decrease the potential bias linked to different age structure, I divide the estimations by population size. Indeed, municipalities with the same number of inhabitants were more likely to have been close in the age structure of their population. I run the regressions on municipalities less than 631 inhabitants, which was the median population level, and on those above this threshold. I also do so on municipalities less than 2 000 inhabitants, which amounts to excluding the top 10% in terms of population from the analysis⁶⁰. I also control by the total number of schools in the municipality.

The effect found is always negative and strongly significant. In municipalities less than 631 inhabitants, one standard deviation increase in the average level of fees between schools (of around 48 cents of francs) was entailing a fall in enrolment between 0.8 and 1.6 pupils per 100 inhabitants, depending on the addition of department wealth controls. The average enrolment in these municipalities was of 13.4 pupils per 100 inhabitants. Therefore, one standard deviation increase in the average level of fees was associated with a fall between 6% and 12% of the

⁶⁰See information on population deciles in Table 1.A13 in the Appendix.

enrolment rate. The effect of such a standard deviation on municipalities more than the median population was a fall of the enrolment rate between 12.5% and 25%. On municipalities less than 2 000 inhabitants, the effect was bounded between 5% and 16%.

Therefore, the impact was close in magnitude between small municipalities below the median population and the bottom 90% of them in terms of population size. Many families in all these municipalities were therefore quite dependent on the cost of education. A fall in the level of fees was inducing a substantive rise in enrolment rates. The similarity of the effect between them also indicates that the age structure of the population was certainly not differing much between the two groups of villages⁶¹. The inclusion of department fixed effects doesn't modify the significance or the magnitude of the outcomes. This effect is in compliance with the comparative study of Maynes, 1979 on France and Prussia. The availability of communal lands, to which teachers could be granted usage, entailed a higher financial support of communities towards education in Prussia. This was also leading to a fall in schooling fees and to higher enrolment rates.

As a robustness check, I substituted the average level of fees by their minimum amount. I still find a negative effect of fees on enrolment, valid for municipalities less than 2 000 inhabitants and more than the median population level. The magnitude of the impact is decreased compared to the previous estimations. This is due to the fact that a fall in the minimum level is only prompting more pupils to enter the school, while a fall in the average level is also associated with pupils staying at school for a longer period of time, which is contributing to increase even more enrolment rates⁶².

The reverse causality issue remains weak in these estimations. Indeed, the level of fees was first set by the teacher after a potential negotiation with municipal authorities. Then, families decided whether or not sending their children to school. Moreover, even if many pupils were subsequently schooled for a given level of fees, there was no strong incentive for teachers to lower this level by themselves. The municipal investment was ensuring them with a financial stability which made this lowering acceptable in the negotiation. However, when no such investment was present, teachers had interest in maximising the income coming from fees, even when enrolment rate was high. Indeed, they were, on average and compared to the other professions, not at ease financially speaking (Lorain, 1837). That is why this occupation was often seen and described as unenviable in the nineteenth century, especially before the Guizot Law which for the first time implemented a minimum annual salary for teachers (Prost, 1968). This argument also applies for these estimations in Table 1.3. Finding an altruistic and wealthy enough teacher, willing to decrease schooling fees, and being rewarded for his involvement in education by municipal authorities afterwards was extremely unlikely.

In another work, I showed that printing presses had a positive impact on the development of primary schooling in France (Montalbo, 2019b). Therefore, one might wonder if the impact

⁶¹The number of town for which average schooling fees are available is too low to run regressions only on towns more than 2 000 inhabitants. The effect found is negative but the number of observations and of clusters become too low to be reliable.

⁶²See Table 1.A14 in the Appendix.

of schooling fees on enrolment could be due to the long term impact of presses. Indeed, they may have favoured both public investment in education and enrolment. Controlling by the proximity to printing presses doesn't modify the significance or the magnitude of the estimates⁶³. Therefore, if the presses did influence primary schooling, municipal investment still contributed significantly to increase enrolment through a lower cost of education. These outcomes are also robust to the control for spatial auto-correlation in the error term and to the control for Protestant influence⁶⁴.

Table 1.5: Average schooling fees and enrolment. Municipality level

	Dependent variable : Pupils per 100 inhabitants								
	(1) Population ≤631 (Med)	(2) Population ≤631	(3) Population ≤631	(4) Population ≥631	(5) Population ≥631	(6) Population ≥631	(7) Population ≤2 000	(8) Population ≤2 000	(9) Population ≤2 000
Average schooling fees	-0.032*** (-5.097)	-0.017*** (-2.802)	-0.016** (-2.530)	-0.020*** (-6.327)	-0.011*** (-3.815)	-0.009*** (-3.153)	-0.028*** (-6.554)	-0.009*** (-3.104)	-0.007** (-2.142)
Number of schools	5.955*** (7.687)	5.966*** (7.434)	5.975*** (7.393)	1.255*** (6.329)	1.533*** (8.799)	1.474*** (8.132)	3.138*** (6.369)	3.667*** (8.307)	3.626*** (8.303)
Number of free pupils	0.073*** (3.625)	0.050** (2.374)	0.054** (2.502)	0.046*** (4.921)	0.036*** (3.806)	0.032*** (3.672)	0.030*** (3.210)	0.016 (1.494)	0.014 (1.339)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	No	Yes	No	No	Yes	No	No	Yes	No
Department fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
District clusters	46	39	46	67	59	67	66	57	66
Observations	965	953	965	859	812	859	1709	1658	1709
R ²	0.505	0.530	0.534	0.723	0.735	0.759	0.609	0.634	0.652

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Average schooling fees is computed in cents of franc as the mean value of fees within each municipality. When only the minimum and maximum values were specified for a given school, the average value in this school was taken as the mean between these two extreme levels.

It could be argued that lower fees within public schools were prompting their private counterparts in the same municipality to also decrease the cost of education in order to attract more pupils. In this case, the effect of fees on enrolment rates would also be due to spillover effects on private schools. However, there were at least one public and one private school in only 6.7% of the municipalities with schools. In only 38 municipalities were there strictly more than one public and one private school. Therefore, it is unlikely that these spillover effects were important in explaining the variations in enrolment rates.

Still, to give further reliability to the previous estimations and to avoid any potential interaction between schools, I restrict the sample of municipalities to those in which only one primary school was present. I do so in order to see if enrolment rates were higher in municipalities with one public school compared to those with one private. Schooling fees were much lower in municipalities with a public school, with an average level of 90 cents of francs against 1.34 in those with one private. Estimation outcomes are displayed in Table 1.6. To ensure an homogeneous age pattern, I restrict the sample to municipalities less than 4 000 inhabitants in the third and fourth columns, which amounts to letting aside around 1% of the municipalities. I do

⁶³See Table 1.A15 in the Appendix.

⁶⁴See Table 1.A16 and Table 1.A17 in the Appendix.

so on municipalities less than 1 000 inhabitants in columns five and six, which is equivalent to keeping the 75% less populated. Selecting other bounds wouldn't change the results which are quite close for any population restriction. The presence of a subsidised school compared to a private one was associated with a reduction of around 0.5 pupils per 100 inhabitants after the introduction of department controls. This corresponded to a 4% increase in enrolment rates.

Table 1.6: Public schooling and enrolment in municipalities with one school.

	Dependent variable : Pupils per 100 inhabitants								
	(1) All sample	(2) All sample	(3) All sample	(4) Population ≤4 000	(5) Population ≤4 000	(6) Population ≤4 000	(7) Population ≤1 000	(8) Population ≤1 000	(9) Population ≤1 000
Subsidised school	1.149*** (3.577)	0.498*** (2.666)	0.432** (2.413)	1.114*** (3.468)	0.481** (2.508)	0.413** (2.256)	1.064*** (2.847)	0.480** (2.074)	0.546** (2.353)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	No	Yes	No	No	Yes	No	No	Yes	No
Department fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
District clusters	71	62	71	71	62	71	64	55	64
Observations	2163	1888	2163	2156	1881	2156	1720	1521	1720
R^2	0.582	0.621	0.653	0.585	0.625	0.657	0.536	0.598	0.610

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Only municipalities with one primary school are selected in these estimations. Municipalities with one public primary school are therefore compared to their counterparts with only one private school.

The estimations in this section may seem to be flawed because of an important missing factor: migrations. It is true that, if the Revolution or any other process caused significant internal or external migrations, the estimations could be biased as immigrants may be positively or negatively selected with respect to education. It is true that the Revolution was associated with the flight of around 140 000 people, but they returned after the fall of Napoléon in 1815. It is also true that numerous studies found that educated people were often migrating more and further away. This is true for migrations internal to France during the nineteenth century (Hefernan, 1989), (Rosental et al., 2000), (Rosental, 2004), (Bonneuil et al., 2008), England at the same period (Hoyler, 1998) or Spain (Tapia and Salanova, 2017). However, the periods of mass migration in France truly began after the mid-nineteenth century, in link with rural exodus towards the industrial north-eastern departments (Duby and Wallon, 1976), (Beltran and Griset, 1994), (Dupâquier, 1995). Therefore, there is no strong reason to think that inter-departmental migrations could affect the results here. Department fixed effects also help taking them into account. For what regards intra-departmental migrations, if more dynamic municipalities lowered schooling fees and attracted more educated people, this might drive some of the association between low fees and high enrolment. This is something that is hard to control for. Still, the relation between fees and enrolment is valid when separating municipalities by population bounds. This helps alleviating the problem as it is unlikely that very dynamic municipalities would be poorly populated. Therefore, since the effect is significant for municipalities less than 2 000 and or 631 inhabitants, this issue seems unlikely to be strong.

5.4 Supply and Demand Factors

Municipalities which invested in education were characterised by a lower schooling cost and a higher enrolment. But was this due to a supply, a demand effect, or both? The estimations presented in this section indicate that it is very likely a combination of both effects. Indeed, municipalities chose to subsidise primary schools through taxation and to decrease the cost of education. Even if one hypothesises that this is only revealing a supply effect and the will of authorities to enhance education, schooling the children was not mandatory until the Ferry Laws. As a consequence, people reacted freely to the fall in education cost and chose to send their children to school. Primary education was valued by families and a higher education cost would have impeded some of them from doing so. Therefore, a demand effect explains part of the association between municipal investment in education and higher enrolment rates. This is in line with recent studies showing that landownership inequalities in Prussia affected negatively primary enrolment through a fall in the demand of education (Cinnirella and Hornung, 2016), (Beltrán Tapia and Martínez-Galarraga, 2018). Economic barriers thus prevented people from sending their children to school. In the French case, these barriers were alleviated by municipal investment, which in turn contributed to enhance the demand for schooling and to satisfy it more fully.

For what regards municipal investment, one may also think that it differed between municipalities because of an unequal representation of the population by local officers. This is in line with the democracy argument on schooling expansion. However, historically, electoral franchise may have mattered less than the fiscal capacity of municipalities. In late 19th century Italy, for example, municipalities which could extract more resources through taxation were also those characterised by higher schooling achievements. This factor was a better predictor of educational development than the extent of the franchise (Cappelli, 2016a). In the early nineteenth-century France, people having the power to influence primary schooling, namely the representatives at the department level (gathered in a *conseil général*) and the members of town councils were not elected. Members of the first of these two councils (both of them have been created during the French Revolution) were named by the government between 1800 and 1833 and then elected by census suffrage (*suffrage censitaire*). Towns councils were suppressed in 1793 and re-established in March 1831, only two years before the Guizot survey. Its members were then also elected through census suffrage⁶⁵. Mayors remained appointed by the King or by the *préfets*⁶⁶, depending on the size of the municipality (Guionnet, 1996), (Guionnet, 1998). Therefore, it is unlikely that the strong variations in municipal investment were shaped by the electoral pressure of people in only two years.

⁶⁵The proportion of people authorised to vote was decreasing with the population of municipalities. Therefore, the threshold of paid taxes giving the right to vote was increasing with this population. For example, in towns with less than 1 000 inhabitants, the most taxed people could vote up to 10% of town population, up to 5% between 1 000 and 5 000 inhabitants, 4% between 5 000 and 15 000 inhabitants and 3% above. In very small municipalities, nearly all adult men had the right to vote. It is estimated that over 32.6 millions of inhabitants, from two to three millions had the right to vote for town council members under this scheme.

⁶⁶The administrative head of the departments.

Even if it is impossible to state that people had no power to influence the decisions of local authorities, it is clear that municipal investment in education could be decided without consulting the population. Local authorities most likely did so in order to maintain the level of educational service provided before the Revolution. Also, they may have tried to increase education as this latter became increasingly required in everyday life. Long term factors as the higher state capacity of regions belonging to the *Cinq Grosses Fermes* from 1664 onwards may also explain the variations in municipal investment (Johnson, 2015)⁶⁷. Municipalities located within these regions were historically collecting more resources through taxation and providing more public goods. This may explain partly why they managed to finance public schooling after the Revolution as their population was accustomed to public intervention and taxation. Therefore, if the demand for education certainly played an important role in the expansion of primary schooling, the supply effect linked to municipal investment also worked partly on its own without being driven by the demand.

Finally, the demand for education may have been affected by the opportunity cost of schooling compared to work. In this case, low enrolment rates could simply reflect higher child wages in industry or agriculture and therefore a higher opportunity cost of education. However, there is no decreasing relation in the data between these two wages and enrolment rates. There is even an increasing relation between agricultural wages of children and enrolment at the district level. These wages were therefore rather an indicator of economic development⁶⁸. In municipalities where children were less paid, women and men were also likely to be so. Then, families were certainly too poor to send their children to school, even when fees were low and education didn't represent a high opportunity cost. Therefore, the effect of schooling fees on enrolment rates was not mediated by the wages of children⁶⁹.

6 Public Education, Teaching Efficiency and Intensive Human Capital Accumulation

So far, I demonstrated that from the Revolution to the Guizot Law, a high concentration of schools was closely associated to a high municipal investment, this latter implying lower schooling fees and higher enrolment rates. In this section, I will show that municipal investment was also linked to better teaching conditions and a higher intensive accumulation of human capital. By intensive, I mean that not only enrolment rates were higher (which would be an

⁶⁷These Cinq Grosses Fermes corresponded to an outsourced customs, excise and tax operation. Tax collectors, the *Fermiers généraux* were charged to collect duties on behalf of the King. This system was covering the centre part of France, represented in white in Figure 1.B6 in the Appendix.

⁶⁸See Figure 1.B7 in the Appendix.

⁶⁹Following the same kind of reasoning, one could argue that the land redistributions under the Revolution in France could have positively affected the demand for education, in line with findings on other countries (Belrán Tapia and Martínez-Galarraga, 2018), (Cinnirella and Hornung, 2016). However, farmers only obtained one-third of these land redistributions, the remaining parts being redistributed to urban landlords. This amounted to an increase of around 3% in the total share of land owned by farmers, which increased from around 40 to 43 (Béaur, 2008). Therefore, it is unlikely that this redistribution actually entailed a strong shift in the demand for schooling, for the vast majority of peasants was not concerned or affected by it.

extensive accumulation of capital, the one exhibited in the previous section), but that pupils were also learning more.

6.1 The Recruitment of More Qualified Teachers

The Guizot survey provides information on the certification level of teachers. After 1816, in order to be able to practise, they had to obtain a certificate delivered after an examination conducted by a civil servant belonging to the ministry of public instruction. Three degrees were composing this school certificate, the third one being the lowest on the hierarchy since teachers could obtain it thanks to a minimum mastering of numeracy and literacy. With additional notions of spelling and calculus, they were likely to obtain the second degree. The first one was only accessible for teachers mastering grammar, land surveying, geography and arithmetic.

In Table 1.7, I regress municipal investment in primary schools on these characteristics in order to know if teachers with a higher certification were more or less likely to be recruited in public schools. In order to analyse the certification's effect, I introduce the three degrees in the estimations to know their impact, compared to the situation in which the teacher had no certificate, on the probability for a teacher to practise in a public school. I do so since 6% of the teachers still didn't abide by the 1816 law and had no certificate in 1833. A positive effect would therefore mean that municipalities tended to more often recruit teachers with a certificate, a signal that the teacher made the efforts to acquire sufficient knowledge to pass the examination. It is also possible that a teacher was already employed in a public school before 1816 and that he was prompted by municipal authorities to abide by the new law after this date. In this case, there was no recruitment of better quality teachers but an in-service training decided by the municipality. If the teacher was not able to do so, the municipality could have very well recruited another one. Consequently, the coefficient associated to the certification degree captures either the effect of the certificate on the probability to be recruited by a public school, or its impact on the probability to be kept in a public school.

All certificate degrees were associated with a higher probability to teach in a public school⁷⁰. The magnitude of the effect was of respectively 10, 9 and 7.6 percentage points for the first, second and third degree. More qualified teachers were therefore more likely to practise in public schools and to be recruited by them. The effect was especially strong on the probability to be paid annually by the municipality, respectively 18, 16.6 and 8.5 percentage points. Only the second degree of certification had a positive effect on the salary's amount and the provision of an accommodation or a classroom. It also had a positive impact on the probability to be granted with another municipal occupation, along with the third level. The absence of significant effect for the first degree when decomposing public subsidies is due to the fact that a teacher with this level of qualification was present in only 1.6% of the primary schools in the database. Therefore, this amounts to restricting highly the number of teachers with this certificate level and a given subsidy.

⁷⁰Descriptively, there were 84% of the teachers with a first-degree certificate practising in public schools, 85% of those with a second-degree and 78% of the teachers with a first-degree.

All in all, teachers who obtained the second degree certificate, 38% of them, were more likely obtain any kind of subsidy and to be paid more. The 54% of teachers who obtained only the third degree were also more likely to be subsidised by the municipalities, but mostly through the provision of a fixed salary or another municipal occupation. Their salary was however on average not significantly higher than the one of subsidised teachers without certificate. This is in line with the fact that these teachers were more often employed in smaller municipalities endowed with lower economic resources compared to the ones with a second-degree certificate. Therefore, these municipalities were more often hiring a teacher and providing him another occupation at the same time. They were also selecting teachers with a certificate and providing them with a fixed salary more often, even if this salary remained low.

Logit estimations confirm these outcomes for the three certification degrees⁷¹. Teachers with a third-degree certificate were around 1.7 times more likely to be provided with municipal grants, 1.6 times to be provided with a fixed salary or another municipal occupation. Teachers with a second-degree certificate were more likely to be granted with any type of subsidy, with a magnitude of around 2 times for the provision of a municipal grant generally speaking.

Table 1.7: Teaching certificates and public primary schooling

	(1)	(2)	(3)	(4)	(5)	(6)
	Subsidised school	Fixed salary	Salary amount	Accommodation	Classroom	Other municipal occupation
First-degree certificate	0.100* (1.714)	0.179*** (2.675)	71.437 (1.351)	0.118* (1.716)	0.073 (0.914)	0.104 (1.444)
Second-degree certificate	0.090*** (2.878)	0.166*** (5.408)	28.973** (2.120)	0.128*** (3.561)	0.073** (2.166)	0.101*** (3.181)
Third-degree certificate	0.076** (2.630)	0.085*** (3.382)	-19.926 (-1.547)	0.028 (0.923)	0.030 (1.014)	0.092*** (3.241)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	74	74	68	73	73	74
Observations	4052	4098	2640	3604	3604	4076
R^2	0.299	0.296	0.320	0.327	0.346	0.344

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Certification degrees' impact is evaluated compared to the situation in which the teacher had no certificate. The salary amount is in francs per year.

6.2 Teaching Characteristics and Progress of Pupils

More qualified teachers were more concentrated in public schools. However, was this higher concentration leading to a greater accumulation of human capital? In the education economics literature, teacher quality has been positively related to educational achievement (Rockoff, 2004), (Rivkin et al., 2005). Teachers' salary in particular has been shown to influence positively

⁷¹See Table 1.A18 in the Appendix.

test scores, whether at the country (Dolton and Marcenaro-Gutierrez, 2011) or at the school level (Nickell and Quintini, 2002), (Britton and Propper, 2016). The main argument behind this influence is that higher salaries would attract better-qualified teachers (Figlio, 1997), their level of qualification being itself positively correlated with teaching quality (Behrman and Birdsall, 1983), (Ehrenberg and Brewer, 1994)⁷². The same kind of reasoning applies here. By recruiting more qualified teachers and by paying them more often, municipalities could have at the same time enhanced human capital accumulation. Also, teachers' salary and the other grants were functioning as performance pay or rewards. Indeed, municipal authorities could freely decide to recruit a new teacher if the incumbent one was deemed inefficient. Therefore, the grants were incentives for teachers to be highly involved in their activity and to make pupils progress. Performance pay has been shown to be positively related to teachers' efficiency, whether at the high school level (Lavy, 2002), (Lavy, 2009), primary school level (Muralidharan and Sundararaman, 2011) or in cross-country comparisons (Woessmann, 2011)⁷³.

To investigate this point, I selected two sets of variables in the Guizot survey that can be taken as indicators of teaching quality and of the volume of knowledge learnt by pupils. The first set corresponds to qualitative variables and the second one to quantitative measures related to the number of subjects learnt and to the average number of years spent at school. The qualitative indicators are all binary variables taking the value one if the school was controlled by the teacher in terms of order, discipline and work. Another indicator is the fact that pupils were making progress and an evaluation of teaching quality, deemed satisfactory or not by the inspector⁷⁴.

In the data, the variables on teaching conditions and quality were coded with four to six items, typically from "very good" to "very bad". I collapsed them into binary variables in order to decrease any inspector-specific effect in the evaluation of teaching quality. If inspectors were not likely to make exactly the same observation about a teacher, there is a fairly good probability that a teacher deemed as bad by a given inspector wouldn't have been reported as good by another one. The recoding used should therefore decrease the likelihood of any bias associated to the individual evaluation of teaching quality.

In Table 1.8, I regress these indicators on public investment. All coefficients are positive and strongly significant⁷⁵. This investment was increasing by around 6 and 7 percentage points the probability of having order and discipline in the classroom, by 10 the probability that pupils worked correctly. The effect on teaching quality had around the same magnitude and the impact on pupils' progress was of 7 percentage points. Teaching quality was therefore higher in

⁷²Even if salary may be the best proxy for quality (Hanushek and Rivkin, 2006), incentives within the classroom (Hanushek, 2003) and class size (Angrist and Lavy, 1999) also matter in explaining teachers' performance.

⁷³More mixed evidence are presented in (Glewwe et al., 2010).

⁷⁴The questions asked in the survey were: "How is the school controlled for what regards order, discipline and work ?", "What is the state of teaching ?", "Are pupils making progress ?".

⁷⁵Logit estimations lead to similar outcomes. See Table 1.A19 in the Appendix. There could be a reverse causality issue here since municipalities may have decided to subsidise a teacher because he was efficient. However it is hard to see why, with a limited amount of resources, local authorities would be prompted to do so if the schools was already functioning well. It is more likely that, by recruiting better teachers and providing them with grants, municipalities were actually voluntarily trying to increase teaching efficiency.

public schools as pupils were more often making progress, within classrooms where teachers were more efficient and the environment more suitable to work. These outcomes are robust to controlling for spatial auto-correlation in the error term⁷⁶.

Decomposing public investment between its different subsidies doesn't modify the results. All grants, except the provision of another municipal occupation which characterised smaller and poorer municipalities, was significantly associated with more progress made by pupils⁷⁷. Municipal grants were therefore efficient incentives prompting teachers' efforts.

Table 1.8: Public primary schooling and teaching characteristics

	(1)	(2)	(3)	(4)	(5)
	Order	Discipline	Work	Teaching	Progress
Subsidised school	0.064** (2.085)	0.068** (2.322)	0.102*** (3.297)	0.094*** (3.122)	0.068*** (2.773)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	73	71	73	74	74
Observations	3708	3381	3376	3570	3544
R^2	0.041	0.044	0.058	0.069	0.055

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *Subsidised school* is a binary variables which is equal to one if the municipality was investing in the school at stake. *Order*, *Discipline*, *Work*, *Teaching* and *Progress* are all binary variables taking the value to one when the school was controlled by the teacher for what regards order, discipline and work, when his teaching was deemed satisfactory and when pupils were making progress.

The association between public schooling and teaching efficiency was greatly due to the fact that more qualified teachers were also more efficient. In Table 1.9, I regress teaching characteristics and the progress made by pupils on the certificate degrees. All three of them are linked with a higher teaching quality. The second degree is the most strongly and significantly associated with this quality and with the progress of pupils⁷⁸. This certificate was the most robustly influencing the probability to be subsidised. Municipalities investing in education were therefore recruiting these teachers to ensure a higher teaching efficiency. All these elements indicate that the accumulation of human capital should have been higher within public primary schools.

⁷⁶See Table 1.A20 in the Appendix for what regards teaching efficiency and the progress of pupils.

⁷⁷See Table 1.A21 and Table 1.A22 in the Appendix.

⁷⁸Using a logit estimation technique leads to the same outcomes. See Table 1.A23 in the Appendix.

Table 1.9: Teaching certificates and teaching characteristics

	(1)	(2)	(3)	(4)	(5)
	Order	Discipline	Work	Teaching	Progress
First-degree certificate	0.078 (0.838)	0.041 (0.447)	0.089 (1.030)	0.379*** (3.995)	0.312*** (2.914)
Second-degree certificate	0.154*** (4.171)	0.135*** (3.577)	0.220*** (5.706)	0.358*** (9.706)	0.297*** (7.572)
Third-degree certificate	-0.026 (-0.815)	-0.036 (-1.022)	0.037 (1.051)	0.122*** (3.809)	0.051 (1.464)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	73	71	73	74	74
Observations	3792	3471	3335	3652	3621
R^2	0.074	0.073	0.098	0.115	0.102

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *Order*, *Discipline*, *Work*, *Teaching* and *Progress* are all binary variables taking the value to one when the school was controlled by the teacher for what regards order, discipline and work, when his teaching was deemed satisfactory and when pupils were making progress. All independent variables are binary, taking the value one if the teacher had a certificate.

6.3 Number of Subjects and Schooling Years

In public schools, teaching characteristics were better and pupils were deemed to make more progress. However, this is only a qualitative indication that they were learning more there than in their private counterparts. The number of subjects taught within classrooms and the average number of years spent at school reported in the Guizot survey are helpful to evaluate if human capital accumulation was higher in these schools. If pupils were indeed learning more, the average number of schooling years should have been higher in the primary school at stake, as well as the number of subjects taught. This last measure was varying between one and eleven subjects which were: religious instruction, reading, writing, spelling, grammar, arithmetic, land surveying, linear drawing, geography, history and music. The most common subjects were religious instruction, reading and writing. The average schooling years were reported between one and nine. The education of pupils was typically beginning at five years old and was rarely extended over fifteen years old in the primary institution, with an average schooling length of five years.

The two measures are complementary. If more subjects were taught in a school, the average schooling years should have been higher too. Indeed, pupils needed to study for a longer period of time in order to master these subjects. It is however not possible with the data to know the proportion of pupils that were learning all the subjects taught. As a consequence, it is hard to say that a higher number of subjects was associated to a greater human capital accumulation

for all pupils. It was at least the case for some of them. The number of schooling years is helpful in specifying this point. Indeed, if the majority of pupils was learning all the subjects, the average schooling years should have been high. If, on the contrary, it was the case for only a minority of them, then this number of years shouldn't have been greatly affected by the fact that some pupils were learning more subjects. Ideally, one would like to have measure on literacy rates, age-heaping or occupational structure within the adult population to confirm the potential effect of municipal investment on human capital accumulation. However, it is very difficult to obtain or trace back this information, when it comes from data on military conscripts, to the municipality level. This is why I stick to primary schooling indicators.

Figure 1.5 displays the histogram of schooling years. The schools are divided in this graph between the ones granted with a given subsidy and the private. Public schools were clearly characterised by a higher number of schooling years. For any type of subsidy, there were around 20% of the schools in which pupils stayed six or seven years, 15% in which they stayed eight or five years. It was on the contrary more common to remain less than six years in the private schools. Indeed, in around 20% of them, pupils studied on average two or four years. In 30%, they studied three years, in 15% five years. The accumulation of human capital was therefore likely to be higher in primary schools since they were characterised by a higher schooling length. The same was true for the number of subjects. Six, seven or eight subjects were more often taught in public primary schools, two, three or four less often than in the private ones⁷⁹.

T-tests confirm this association between public investment and a higher accumulation of human capital. Indeed, around 4.8 subjects were taught in public schools against 4.6 in the private. Pupils were on average spending 5.3 years in subsidised schools and around 4 in their private counterparts. These mean values are all statistically different at a one-percent level. Each type of subsidy (a fixed salary, an accommodation, a classroom and another municipal occupation) was associated both to a significantly higher number of subjects taught and of schooling years⁸⁰. This is a strong indication that teachers wanted to keep children longer in the public schools and making them learn more. Indeed, they could have tried to keep them a minimum amount of years, once they benefited from public grants, since they were less dependent on fees and were provided with a higher financial stability. In this case, they would have been paid or accommodated with only a small number of pupils to teach. Being granted with municipal subsidies was also likely to be a strong incentive to be involved in the education of children. Indeed, apart from the fixed salary which was annually provided, municipalities could get rid of the teacher pretty easily if he wasn't deemed good enough by parents or the local authorities themselves.

⁷⁹See Figure 1.B8 in the Appendix.

⁸⁰See Table 1.A24 and Table 1.A25 in the Appendix. The number of subjects didn't differ significantly between schools where the teacher was provided with another municipal occupation and the others.

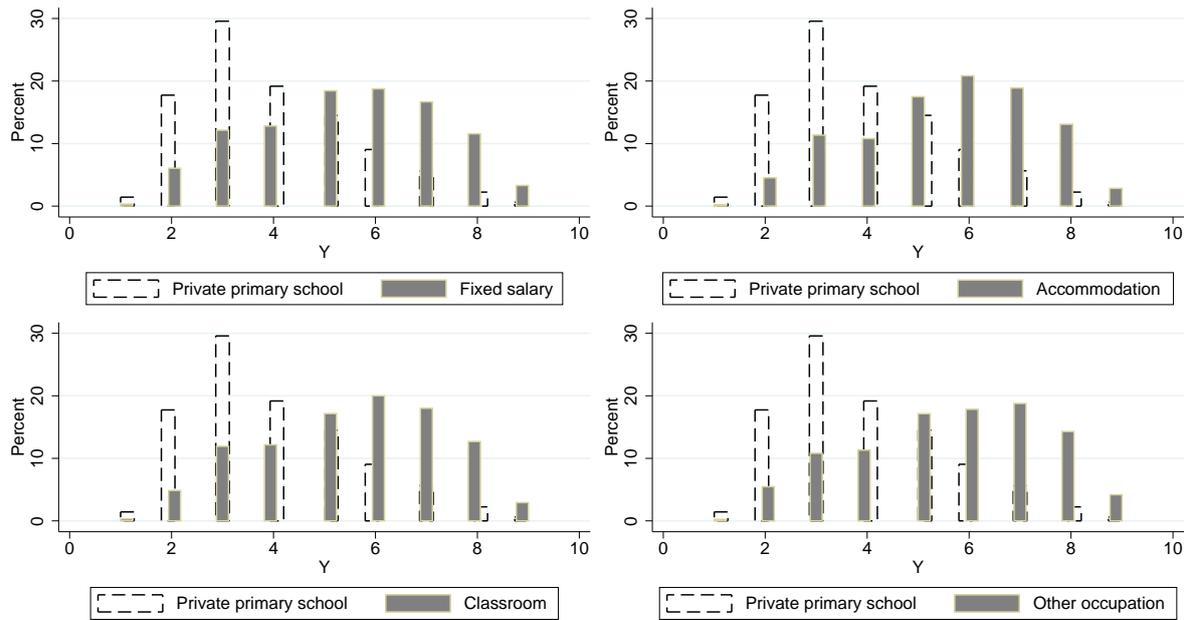


Figure 1.5: Public schooling and schooling years - Histograms

Source: Guizot survey

Notes: Each bar in the histograms represents the percentage of observations corresponding to a given number of schooling years. Therefore, it represents the percentage of primary schools for each number of years. The schools are divided between those which were granted with public subsidies and the private ones. Each subsidy is therefore compared to the same histogram of schooling years drawn only for private schools.

Estimation outcomes in Table 1.10 indicate that public investment was increasing the number of subjects by 0.34 on average, and the number of schooling years by 0.29. Both effects are significant at a one-percent level. In this table, I also add estimations on the probability that a given subject was taught in the primary school. I exclude religion, reading and writing since they were taught in nearly all schools⁸¹. Arithmetic was taught in 62% of the schools for which this specification is available, grammar in 44%, spelling in 49%, geography and linear drawing in 7%, land surveying in 10%, history and music in around 3%. All the percentages were significantly higher in public schools, except for arithmetic, geography and history. Grammar and spelling were for example taught in respectively 46 and 53% of the primary schools, against 38 and 35% of the private ones⁸².

The outcomes demonstrate that pupils were more likely to learn arithmetic, grammar, spelling and linear drawing in a public school. The increase in the associated probability that these subjects were taught is respectively of 8.2, 8.6, 8.3 and 2.8 percentage points. The effect is particularly strong for arithmetic, grammar and spelling. Therefore, the accumulation of human capital was higher in public schools thanks to a higher probability to learn arithmetic, grammar, spelling and, for a much lower number of pupils, linear drawing⁸³. Teaching in these schools was not limited to the basics of literacy and to religious instruction. By recruiting better teachers more likely to be able to teach several subjects, and by lowering the cost of education,

⁸¹They were so in respectively 99.4, 98.4 and 92.1% of the primary schools for which this information is available.

⁸²See Table 1.A26 in the Appendix.

⁸³Logit estimations indicate that arithmetic was 1.6 times more likely to be taught in a public school, along with grammar and spelling. Linear drawing was 2.7 times more likely to be so. See Table 1.A27 in the Appendix.

municipalities increased the probability for pupils to learn more and in better conditions. These outcomes are robust to controlling for spatial autocorrelation in the error term⁸⁴.

Table 1.10: Public schooling and human capital accumulation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Number of subjects	Schooling duration	Arithmetic	Grammar	Spelling	Geography	Land surveying	Linear drawing	History	Music
Subsidised school	0.344*** (4.373)	0.289*** (2.976)	0.082*** (2.973)	0.086*** (3.564)	0.083*** (3.617)	0.017 (1.094)	0.006 (0.534)	0.028** (2.449)	0.011 (1.539)	-0.004 (-0.439)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	70	70	70	70	70	70	70	70	70	70
Observations	3732	3628	3732	3732	3732	3732	3732	3732	3732	3732
R^2	0.134	0.506	0.187	0.153	0.270	0.069	0.082	0.045	0.047	0.094

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Note: All subject names correspond to binary variables taking value one if the subject was taught in the primary school.

7 Conclusion

After the shock of the Revolution, primary schooling reorganised around municipal investment. In areas previously well-endowed in primary schools and where economic resources were higher, municipalities took over the control of education. This modification in the supply of schools was most likely partly influenced by demand factors. Municipalities contributed to a higher financial stability of teachers and reinforced their presence by providing them with a fixed salary, a classroom, an accommodation or an additional municipal employment. In poorer areas, on the contrary, schools remained more scarce and more often private, only financed through fees. But municipalities went beyond the mere financing of schools and acted vigorously to decrease the cost of education by lowering the level of schooling fees. Teachers accepted this decrease in exchange for a higher financial ease. This led to an increase in enrolment rates within public schools compared to their private counterparts, as primary education came at a lower cost for families. The fact that families responded to lower schooling fees also indicate that the demand for education was high in the municipalities at stake.

Teachers recruited in schools provided with municipal grants had on average a higher level of certification. Teaching conditions and progress made by the pupils were more often deemed as satisfactory within these schools. The number of subjects taught, as well as the average schooling years, were also higher in public schools. By lowering the fees and recruiting more qualified teachers, municipalities prompted more children to attend schools and to attend them for a higher number of years. Public investment therefore had a positive effect both on the extensive and intensive margins of human capital accumulation.

Even after the Guizot law of 1833, many municipalities (especially those below 500 inhabitants) remained without a school. Variations in schools' presence, enrolment and literacy rates were

⁸⁴See Table 1.A28 in the Appendix.

far from being absorbed in the mid-nineteenth century and even in the 1870s, in spite of a first convergence between departments and districts which was already at work. The early involvement of municipalities to increase enrolment and the accumulation of human capital appears to have been an essential factor in accounting for the long-lasting variations in educational attainment in France during the nineteenth century.

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Appendix

Data and Descriptive Statistics

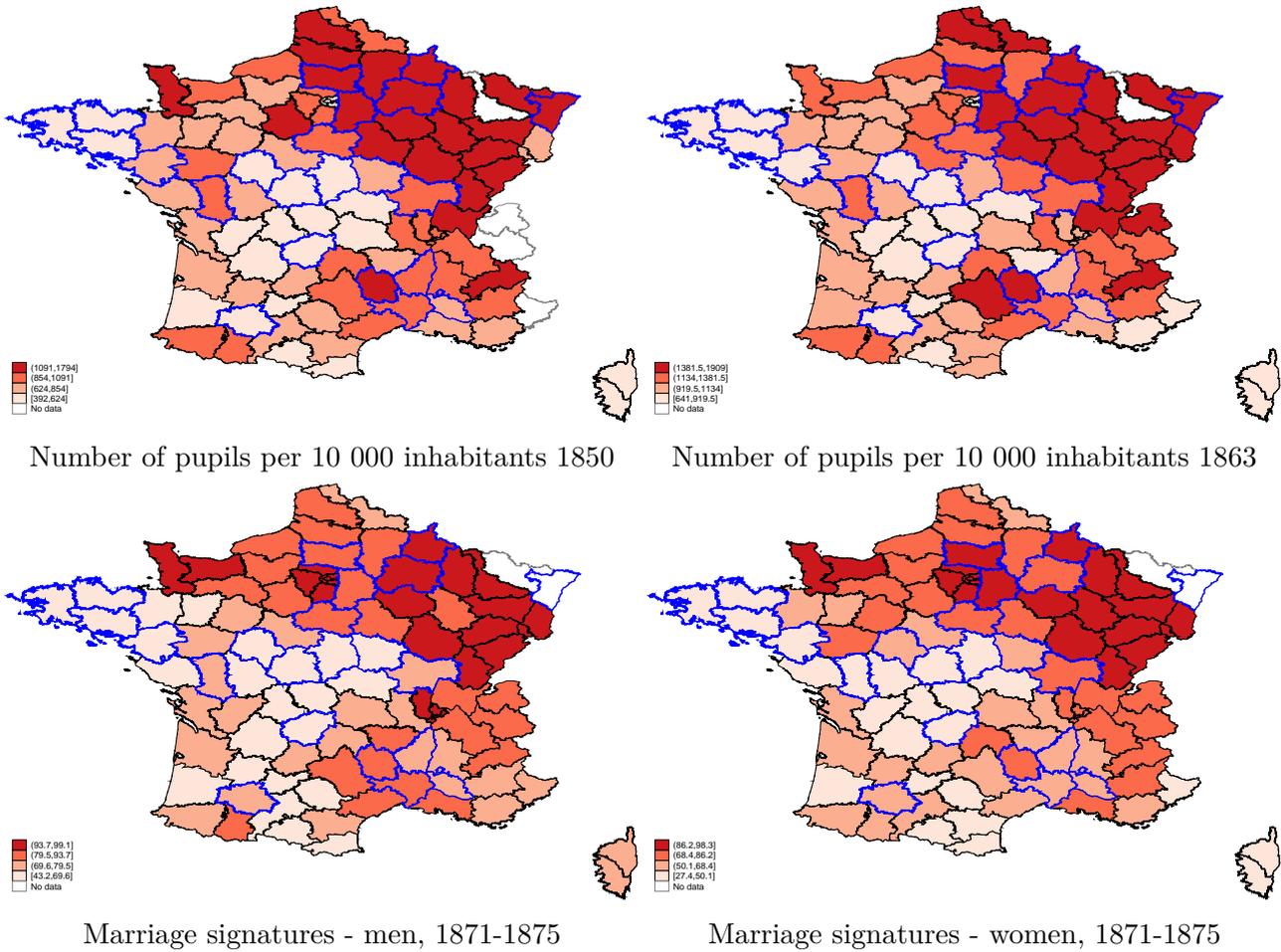


Figure 1.B1: Enrolment in primary schools

Source: *Statistique générale de la France*.

Note: All types of schools are taken into account, whether public or private.

The Guizot survey

The reliability of the data coming from the Guizot survey appears to be strong if one relies on the official information related to its implementation. In the *Circulaire adressée à MM. les recteurs relativement à l'inspection générales des écoles primaires* of the 28th of July 1833⁸⁵, Guizot asserted that:

"Ces renseignements sont d'une utilité incontestable, et je ne négligerai aucun moyen de les rendre de plus en plus exacts et complets. Mais il n'importe pas moins de bien connaître le régime intérieur des écoles, l'aptitude, le zèle, la conduite des instituteurs, leurs relations avec les élèves, les familles, les autorités locales, l'état moral en un mot de l'instruction primaire et ses résultats définitifs. Les faits de ce genre ne peuvent être recueillis de loin, par voie de correspondance et de tableaux. Des visites spéciales, des conversations personnelles, la vue immédiate des choses et des hommes sont indispensables pour les reconnaître et les bien apprécier."

This implies that he absolutely wanted the inspectors to go within the primary schools, observe the teachers' practice and ability, the progress of pupils, and ask them directly the questions related to the enrolment or to their personal situation. The same diligence is expressed in his *Report to the King* (Guizot, 1834). Thus, apparently, the data should have been collected meticulously. On this point, there is little doubt that most inspectors indeed asked the questions to the teachers directly and entered the primary schools to observe their functioning. Moreover, the mayor was provided the information if the teacher was absent or the school inaccessible due to its very distant location from the village.

However, the data's reliability may be partly questioned for two major reasons. Firstly, the Guizot survey can be considered as a political gesture. Secondly, difficulties and approximations inherent to the collection might have made some questions less reliable than the others.

Centralisation became a growing concern under the Revolution and the July Monarchy, associated with a will to make the country more homogeneous and to reduce local or regional particularities (Chartier, 1992). In this context, one might think that Guizot had an interest in presenting a gloomy picture of education in order to increase political and popular support for his law. This may make the reliability of data on primary schools' presence, enrolment rates, or even the qualitative evaluations of inspectors on the state of education dubious. This can be partly true and there is unfortunately no way to control for that. Nonetheless, the concordance between the data coming from this survey and the evaluations made by the *préfets* and reported for example in Dupin, 1826 seems to alleviate part of this potential bias.

On this point, it is extremely useful to look at the description of the inspectors' work made by Louis-Arsène Meunier. Meunier was a teacher in the Eure department and one of its inspectors. He wrote one of the rare descriptions of the collection of data from the Guizot survey.

⁸⁵ *Bulletin Universitaire*, t.3, bul. n° 57 bis, p.317.

His memoirs were not published until 1981 (Meunier, 1981). In theory, every primary school of every municipality had to be inspected. However, bad weather, the mediocre quality of roads, finding an appropriate shelter, or the vague indications of local people clearly made the collection of data complicated. Still, Meunier visited all the primary schools he had to. He was often accompanied by the mayor and the local notables during his inspection. On this point, one must remember that the inspectors were teachers or members of the education system of the department, rectors for example. Therefore, their implication should have been higher than if they were simply employed to inspect the classes.

There is however a higher risk of biases and approximations in the qualitative evaluation that inspectors had to make. Meunier is frank about the state of primary schooling, and doesn't seem to hesitate to express his concerns if the school was badly managed or the teacher inefficient. One can be pretty confident about the reliability and sincerity of his description. However, the qualitative evaluation may have been hampered by the limited amount of time one inspector could dedicate to each school. For example, evaluating the progress of pupils may have been complicated by simply assisting to one class. The inspectors should have of course been able to see quickly if the teacher was sufficiently good so that children could progress or not. But the approximation in the evaluation was necessarily higher for this type of indicator. This is why one must be careful when using the data related to qualitative evaluation by the inspectors. The reliability is certainly higher for what regards the objective characteristics of the schools, as the public subsidies for example or the number of pupils, which could be directly and more easily evaluated. This is why it is important to always look at several indicators to reduce the probability of focusing on a flawed measure.

Table 1.A1: Data representativeness, means and t-tests

	France	Municipal level sample	t-test
Population	91 948	85 794	NS
Number of municipalities	105	90	***
Percentage of population scattered	49.4	55.4	*
Average altitude - meters	300	211	***
Surface area - hectares	1 566	1 869	***
Percentage of municipalities with schools	71.5	60.8	***
Primary schools per 100 municipalities	215	79	NS
Teachers with a fixed salary per 100 municipalities	48.1	51.9	NS
Teachers with an accommodation per 100 municipalities	43.6	46.8	NS
Pupils per 100 children and single people	19.9	16.5	**
Percentage of municipalities with factories	17.2	21.6	**

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Guizot, industrial and postal surveys. IGN data and *Statistique générale de la France*.

Notes: All figures are computed at the level of districts. The average population in each district was respectively around 85 794 inhabitants for those belonging to the municipality level sample and around 91 948 inhabitants for the entire France. The difference between the two is non-significant.

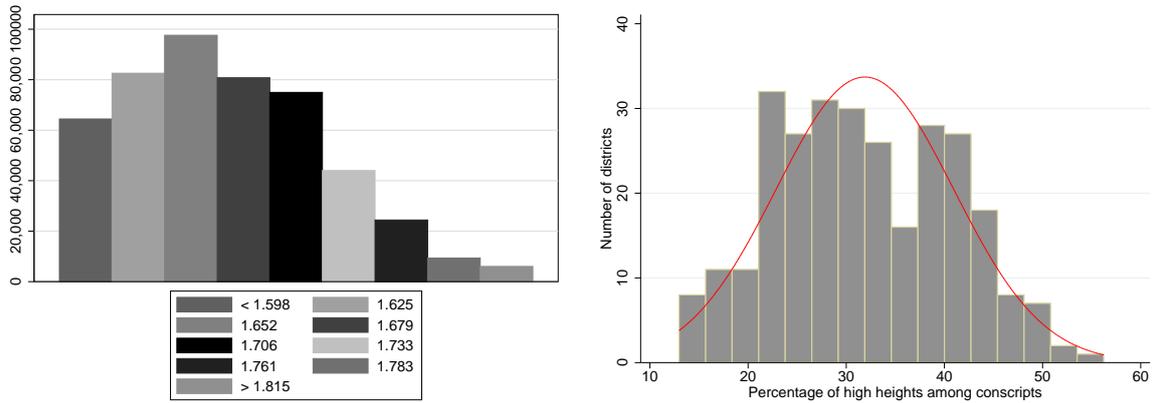
Table 1.A2: Education Summary Statistics - District level

Variable	Mean	Std. Dev.	Min.	Max.	N
Percentage of municipalities with schools	68.6	23	17.8	100	355
Primary schools per 100 municipalities	95	60.6	26	753.3	357
Public schools per 100 municipalities	57.1	33.4	1.9	160.7	357
Accommodation or allowance per 100 schools	44.5	26.7	1.6	92.9	355
Paid teachers per 100 schools	49.1	27.8	2.9	105.1	350
Average schooling fees (in francs)	1.2	0.5	0.2	2.9	357
Pupils per 100 children and single people	19	13.7	2.3	54.4	351
Percentage of municipalities with schoolhouses	39.4	24.7	0	99.1	357
Schoolhouses per 100 municipalities	51.5	40.7	0	267.9	357
Schoolhouses owned per 100 municipalities	26.7	27.5	0.9	248.5	343
Schoolhouses rented per 100 municipalities	28.8	27.6	0.6	250	319
Population dispersion	50.9	27.12	2.52	89.59	355
Factories' presence	9.46	10.05	0	81.48	355

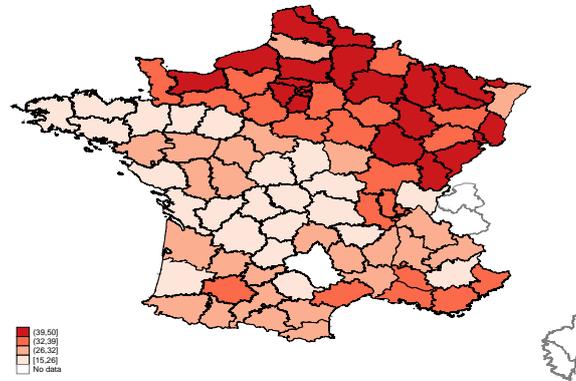
Source: Guizot, industrial and postal surveys. IGN data and *Statistique générale de la France*.

Notes: All variables are at the districts level. The percentage of municipalities with at least a primary school lied between 17.8 and 100%, with an average value of 68.6% and a standard deviation of 23. The number of teachers provided with an accommodation or a fixed salary per 100 schools may exceed the value of 100 since several teachers could be granted so in the same primary school. Factories' presence is defined as the percentage of municipalities with factories more than ten workers.

Municipal Investment in Primary Schooling



Number of conscripts by height intervals in Histogram of the percentage of high heights meters (1819-1830) (1819-1830)



Percentage of high heights among conscripts

Figure 1.B2: Height of military conscripts

Source: Military data on conscripts from (Aron et al., 1972).

Notes: In the first sub-figure, all numbers indicate lower bounds for the intervals except the first one which indicates that all conscripts below the minimum height of 1.598 meters are gathered in the first interval.

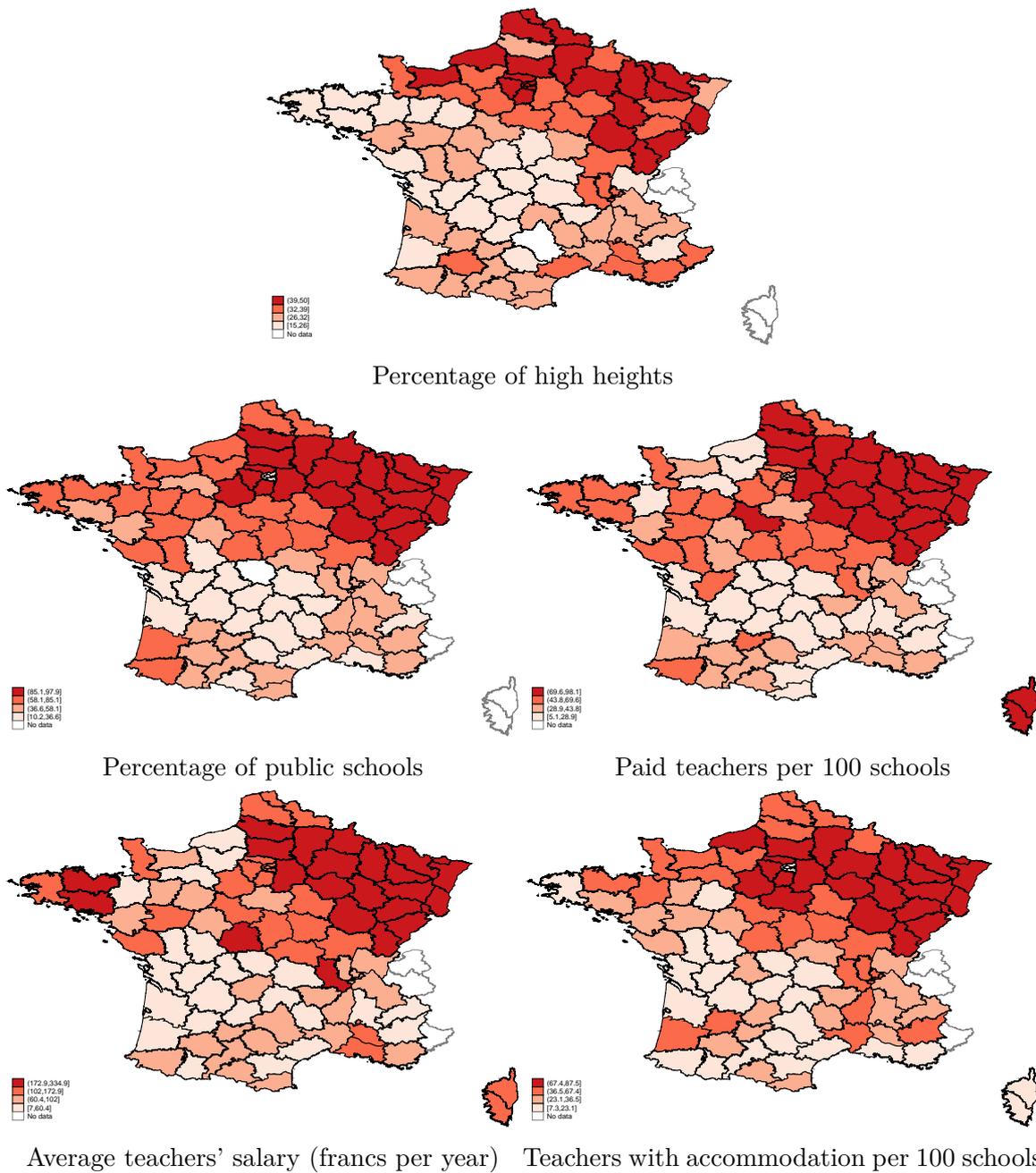


Figure 1.B3: High heights among conscripts and municipal investment primary schooling

Source: Guizot survey and military data on conscripts from (Aron et al., 1972).

Description of data used in the estimations

Municipal-level estimations - controls

- Demographic and geographic municipal controls : population (in 1801, 1806, 1821, 1826, 1831), population dispersion, altitude, surface area of municipalities
- Economic municipal controls : presence of a factory, number of industrial workers, value of taxes on industrial production, number of engines
- District level controls : number of children and single people
- Department level controls : number of presbyteries, length of water and roads communication networks, price of wheat in 1799, amount of taxes on doors and windows, production of cereals, life expectancy at birth

District-level estimations - controls

- District level controls : population (in 1801, 1806, 1821, 1826, 1831), average population dispersion within municipalities, average altitude and surface area of municipalities, percentage of municipalities with factories, number of industrial workers, value of taxes on industrial production, number of engines, number of children and single people, district with prefecture
- Department level controls : same as for the municipal-level estimations

School-level estimations - controls

All the controls are the same as for the municipal-level-estimations, adding controls at the school level: number of subjects, coeducation, boarding school, admission age, schooling length, level of teachers' certification, persons at charge for teachers, progress by pupils, presence of textbooks, books in sufficient amount.

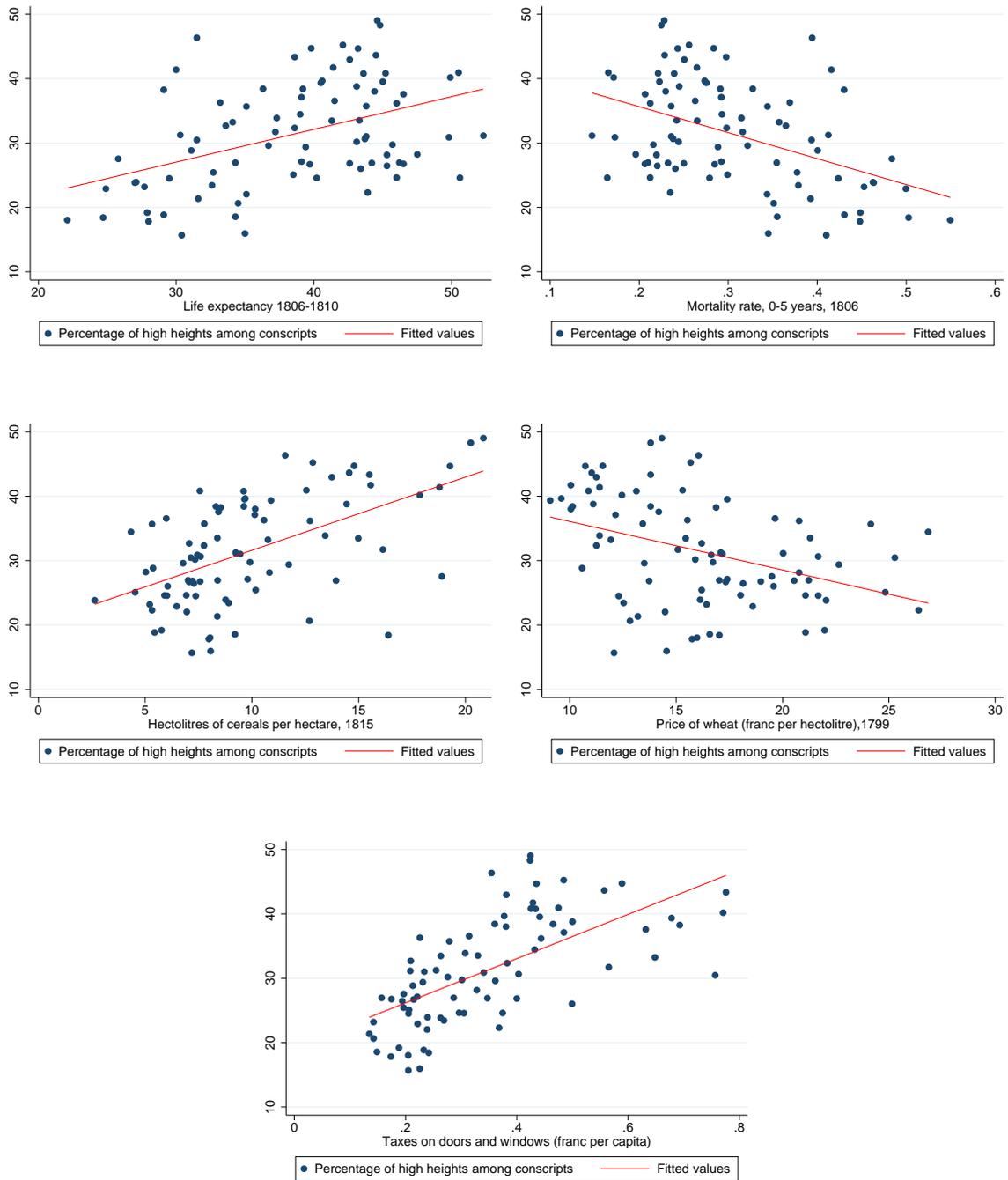


Figure 1.B4: High heights among conscripts and development indicators

Source: Military data on conscripts from (Aron et al., 1972). See main text for other indicators.

Table 1.A3: Heights of conscripts and primary schooling - Beta coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	Percentage of municipalities with primary schools	Primary schools per 100 municipalities	Public schools per 100 municipalities	Accommodation or allowance per 100 schools	Paid teachers per 100 schools	Enrolment
High heights among conscripts	0.272*** (3.652)	0.244*** (2.696)	0.207*** (3.525)	0.176** (2.121)	0.164** (2.260)	0.257*** (3.484)
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	268	264	270	268	264	267
R^2	0.563	0.505	0.701	0.592	0.596	0.689

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *High heights among conscripts* refers to the percentage of conscripts in each district taller than national mean. The *enrolment* rate is defined as the number of children attending schools in winter per 100 children and single people.

Table 1.A4: Heights of conscripts and primary schooling - Robustness check on Protestant influence

	(1)	(2)	(3)	(4)	(5)	(6)
	Percentage of municipalities with primary schools	Primary schools per 100 municipalities	Public schools per 100 municipalities	Accommodation or allowance per 100 schools	Paid teachers per 100 schools	Enrolment
High heights among conscripts	0.725*** (3.386)	0.975** (2.400)	0.916*** (3.817)	0.675** (2.286)	0.505* (1.876)	0.317*** (2.726)
Percentage of Protestants - 1861	0.235 (1.477)	0.553* (1.888)	0.885*** (4.177)	0.866*** (4.352)	0.031 (0.124)	-0.229 (-1.653)
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
Department clusters	81	80	81	81	81	81
Observations	268	264	270	268	264	267
R^2	0.565	0.511	0.716	0.614	0.596	0.694

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *High heights among conscripts* refers to the percentage of conscripts in each district taller than national mean. *Population dispersion* is the percentage of population which was reported scattered in the Postal Survey, based on a contiguity criterion (Roncayolo, 1987). *Factories' presence* is the percentage of municipalities in which at least one factory more than ten workers was located. The *enrolment* rate is defined as the number of children attending schools in winter per 100 children and single people.

Table 1.A5: Too small conscripts and primary schooling

	(1)	(2)	(3)	(4)	(5)	(6)
	Percentage of municipalities with primary schools	Primary schools per 100 municipalities	Public schools per 100 municipalities	Accommodation or allowance per 100 schools	Paid teachers per 100 schools	Enrolment
Too small conscripts	-1.080*** (-4.370)	-1.548*** (-3.505)	-0.907** (-2.484)	-0.415 (-1.127)	0.012 (0.042)	-0.343*** (-2.691)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	Yes	Yes
Department clusters	82	82	82	82	82	82
Observations	271	266	273	271	267	270
R^2	0.569	0.514	0.698	0.591	0.591	0.682

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *too small conscripts* refers to the number of percentage of examined 20 years old boys too small to fulfil military duties, that is to say less than 1.57 meters. Its standard deviation is of 5.8.

Table 1.A6: Heights of conscripts and primary schooling. Municipal level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Primary School	Fixed salary	Salary amount	Accommodation	Classroom	Other salary	Other salary amount
High heights among conscripts	0.017*** (3.659)	0.013*** (3.616)	2.989** (2.209)	0.009*** (3.162)	0.014*** (4.868)	0.013*** (2.924)	1.716*** (3.621)
Department wealth controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	75	75	75	75	75	72	75
Observations	6324	6324	6324	6324	6324	3559	6324
R^2	0.302	0.297	0.308	0.246	0.262	0.302	0.150
High heights among conscripts	0.017*** (3.041)	0.012*** (2.665)	1.140 (0.627)	0.017*** (5.670)	0.014*** (3.339)	0.008 (1.053)	2.309*** (2.952)
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	75	75	75	75	75	72	75
Observations	6324	6324	6324	6324	6324	3559	6324
R^2	0.371	0.371	0.393	0.305	0.315	0.319	0.157
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *high heights among conscripts* refers to the percentage of conscripts in each district taller than national mean. *Primary school*, *Fixed salary*, *Accommodation* and *Other salary* are all dummy variables taking value one if there was at least one primary school in the given municipality, at least one teacher paid by this municipality, at least one teacher provided with an accommodation, at least one with another municipal occupation. The *Salary amount* and *Other salary amount* correspond to the teachers' annual wages in francs.

Table 1.A7: Heights of conscripts and schoolhouses. District level

	(1)	(2)	(3)	(4)
	Percentage of municipalities with schoolhouses	Schoolhouses per 100 municipalities	Schoolhouses owned per 100 municipalities	Schoolhouses rented per 100 municipalities
High heights among conscripts	0.598* (1.794)	1.419*** (4.410)	1.057*** (4.465)	0.311 (1.133)
Population dispersion	-0.207** (-2.194)	-0.506*** (-4.194)	-0.289*** (-2.836)	-0.243** (-2.172)
Factories presence	0.153 (1.216)	0.699*** (3.103)	0.480*** (3.690)	0.316* (1.799)
Demographical and geographical controls	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes
Department clusters	74	73	74	74
Observations	249	243	241	225
R^2	0.477	0.588	0.599	0.354

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *high heights among conscripts* refers to the percentage of conscripts in each district taller than national mean. *Population dispersion* is the percentage of population which is reported scattered in the Postal Survey, based on a contiguity criterion (Roncayolo, 1987). *Factories' presence* is the percentage of municipalities in which at least one factory more than ten workers was located. The *Percentage of municipalities with schoolhouses* corresponds to municipalities in which the number of schoolhouses was evaluated as sufficient in the Guizot survey, meaning that all teachers in the municipality at stake could benefit from such premises.

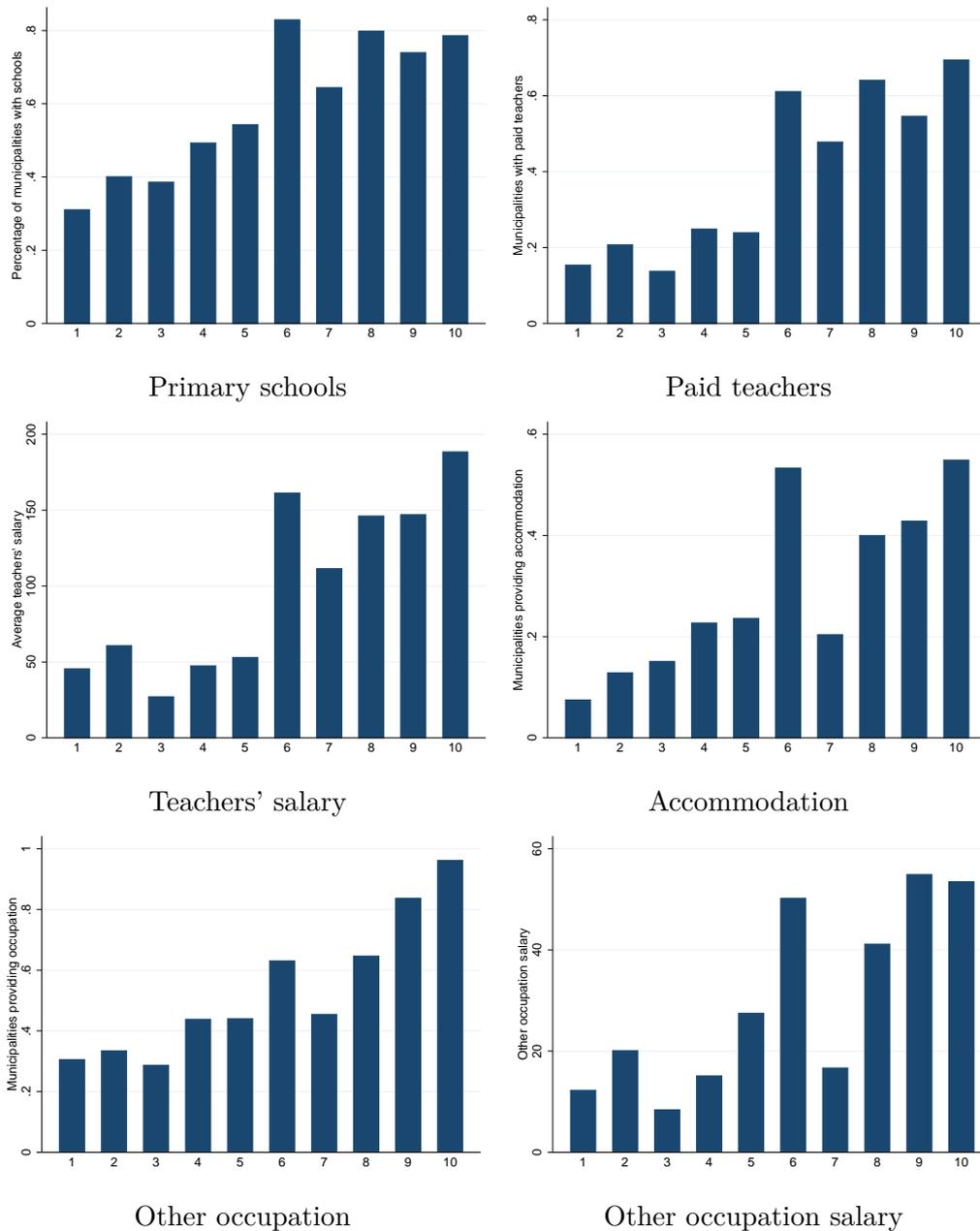


Figure 1.B5: Deciles of the percentage of high heights among conscripts and primary schooling. Municipality level

Source: Military data on conscripts from (Aron et al., 1972), Guizot survey.

Notes: The deciles are related to the percentage of high heights among conscripts. It means that the percentage of municipalities where at least one primary school was present or a teacher was paid, ... is given for every decile of the percentage of high heights. For example, a primary schools was present in around 80% of the municipalities in districts belonging to the top decile of high heights.

Schooling Fees and Enrolment Rates

Table 1.A8: Descriptive statistics, schooling fees and wages

	Average value	
Schooling fees (districts)	1.21	Monthly
Schooling fees (municipalities)	0.96	Monthly
Minimum schooling fees (municipalities)	0.9	Monthly
Industrial male workers	1.97	Daily
Industrial female workers	0.93	Daily
Industrial child workers	0.65	Daily
Agricultural male day-worker	1.4	Daily
Agricultural female day-worker	0.9	Daily
Agricultural child day-worker	0.6	Daily

Source: Guizot, industrial and agricultural surveys.

Notes: The average schooling fees amount at the district level was 1.21 francs. This corresponds to what was paid to teachers each months by families so that their children could attend primary schools.

Table 1.A9: Subsidised primary schools and schooling fees - District level

	Average schooling fees				
	(1)	(2)	(3)	(4)	(5)
Percentage of municipalities with primary schools	-0.006*** (-3.628)	-	-	-	-
Public schools per 100 municipalities	-	-0.005*** (-3.607)	-	-	-
Percentage of public schools	-	-	-0.007*** (-4.066)	-	-
Paid teachers per 100 schools	-	-	-	-0.004*** (-3.225)	-
Accommodation or allowance per 100 schools	-	-	-	-	-0.001 (-1.016)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes	Yes	Yes
District clusters	74	74	74	74	74
Observations	247	249	249	244	247
R^2	0.718	0.721	0.728	0.718	0.701

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Average schooling fees are defined in francs.

Table 1.A10: Schooling subsidies and schooling fees above and below the St-Malo/Geneva line - Primary school level

St-Malo/Geneva line:	Departments above				Departments below			
	(1) Minimum schooling fees	(2) Computed average schooling fees	(3) Average schooling fees	(4) Maximum schooling fees	(5) Minimum schooling fees	(6) Computed average schooling fees	(7) Average schooling fees	(8) Maximum schooling fees
Subsidised school	-19.830** (-2.449)	-20.931** (-2.388)	-33.461** (-2.700)	-42.212*** (-2.901)	-12.627** (-2.210)	-12.118** (-2.204)	-13.499* (-1.946)	-9.538 (-1.414)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	30	29	24	30	39	36	23	37

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Departments above the St-Malo/Geneva line are: Ardennes, Marne, Seine et Marne, Oise, Loiret, Bas-Rhin, Saône et Loire, Nièvre and Cher.

Table 1.A11: OLS estimations - Schooling subsidies and schooling fees - Primary school level. Robustness check accounting for spatial autocorrelation

Spatial standard errors:	25 km radius			50 km radius			75 km radius			100 km radius		
	(1) Min.	(2) Comput. Av.	(3) Max.	(4) Min.	(5) Comput. Av.	(6) Max.	(7) Min.	(8) Comput. Av.	(9) Max.	(10) Min.	(11) Comput. Av.	(12) Max.
Schooling fees:												
Subsidised school	-12.281** (2.776) [4.934]	-9.412* (3.017) [4.833]	-11.582** (3.910) [5.808]	-12.281*** (2.776) [4.655]	-9.412* (3.017) [4.992]	-11.582** (3.910) [5.782]	-12.281*** (2.776) [4.552]	-9.412* (3.017) [5.151]	-11.582** (3.910) [5.731]	-12.281*** (2.776) [4.325]	-9.412* (3.017) [5.230]	-11.582** (3.910) [5.804]
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1992	1443	1611	1992	1443	1611	1992	1443	1611	1992	1443	1611

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Heteroskedasticity-robust standard errors (White standard errors) are reported in brackets. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation. 'Comput. Av.' refers to the computed average schooling fees.

In Table 1.A12, I use the 1851 Census to approximate the number of children in each district in 1833. To do so, I take the number of pupils between 5 and 15 years old within departments. I consider these age bounds since, in 87% of the cases, the admission age reported in the data coming from the Guizot survey was superior or equal to five. The length of primary instruction was also always lower than 10 years.

Then, I take the proportion that a given district represented in the department population to be equal to what it represented in the children population. This assumes the age distribution between adults and children to have been the same for a department and its districts. In districts with a more urban and young population than the average department level, the two distributions may have differed. However, there is a correlation of 0.97 between the number of children and single people in 1831 and the approximated number of children in 1851. This tends to confirm that the computation is actually quite close to the real number of children within districts. This measure has a mean of 24.6%, with a median enrolment value of 19%.

Table 1.A12: Schooling fees and enrolment rates - District level

	Pupils per 100 children			
	(1)	(2)	(3)	(4)
Average schooling fees	-8.806*** (-5.875)	-6.637*** (-3.806)	-5.044*** (-3.473)	-4.699*** (-2.798)
Demographical and geographical controls	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes
Ratio of public schools	No	Yes	No	Yes
Department wealth controls	No	No	Yes	Yes
Department clusters	81	81	74	74
Observations	266	266	245	245
R^2	0.795	0.798	0.872	0.872

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Average schooling fees are defined in francs.

Table 1.A13: Population Deciles - Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
First decile	177.54	43.12	30	239	809
Second decile	287.37	27.07	240	331	812
Third decile	376.25	26.84	332	420	800
Fourth decile	466.11	26.83	421	512	809
Fifth decile	569.95	35.07	513	631	806
Sixth decile	702.37	41.63	632	777	804
Seventh decile	869.04	56	778	975	805
Eighth decile	1114.38	89.7	976	1283	808
Ninth decile	1548.59	185.12	1284	1935	805
Tenth decile	3791.35	4749.73	1938	75895	806

Source: Statistique générale de la France.

Notes: The average municipal population in the first population decile was 178 inhabitants. The minimum value was 30 inhabitants and the maximum 239 inhabitants. The standard deviation was around 43.

Table 1.A14: Minimum schooling fees and enrolment. Municipality level

	Dependent variable : Pupils per 100 inhabitants								
	(1) Population ≤631 (Med)	(2) Population ≤631	(3) Population ≤631	(4) Population ≥631	(5) Population ≥631	(6) Population ≥631	(7) Population ≤2 000	(8) Population ≤2 000	(9) Population ≤2 000
Minimum schooling fees	-0.033*** (-3.944)	-0.011 (-1.462)	-0.010 (-1.480)	-0.022*** (-7.599)	-0.009*** (-3.197)	-0.011*** (-3.733)	-0.030*** (-6.413)	-0.006 (-1.665)	-0.006* (-1.718)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	No	Yes	No	No	Yes	No	No	Yes	No
Department fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
District clusters	52	45	52	70	61	70	68	59	68
Observations	1152	1021	1152	1184	971	1184	2170	1853	2170
R^2	0.503	0.562	0.556	0.739	0.718	0.781	0.605	0.640	0.661

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: The minimum level of fees is defines in cents of franc.

Table 1.A15: Average schooling fees and enrolment. Municipality level. Robustness check, control for printing presses number

Dependent variable : Pupils per 100 inhabitants									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Population ≤631 (Med)	Population ≤631	Population ≤631	Population ≥631	Population ≥631	Population ≥631	Population ≤2 000	Population ≤2 000	Population ≤2 000
Average schooling fees	-0.032*** (-5.233)	-0.017*** (-2.774)	-0.017*** (-2.820)	-0.020*** (-6.338)	-0.011*** (-4.120)	-0.009*** (-3.466)	-0.028*** (-7.407)	-0.008*** (-3.123)	-0.006** (-2.099)
Printing presses within 100kms	0.620*** (4.032)	0.699*** (4.614)	0.907*** (5.766)	0.035 (0.321)	0.173 (1.552)	0.109 (0.779)	0.262* (1.966)	0.379*** (2.992)	0.288** (2.259)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department wealth controls	No	Yes	No	No	Yes	No	No	Yes	No
Department fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
District clusters	46	39	46	67	59	67	66	57	66
Observations	895	883	895	804	759	804	1589	1540	1589
R ²	0.491	0.511	0.518	0.724	0.736	0.760	0.614	0.637	0.653

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text. (ISTC, 1998) and (Febvre and Martin, 1999) for data on printing presses.

Notes: Average schooling fees is computed in cents of franc as the mean value of fees within each municipality. When only the minimum and maximum values were specified for a given school, the average value in this school was taken as the mean between these two extreme levels. Printing presses within 100kms correspond to the number of presses located within 100kms around municipalities at stake.

Table 1.A16: OLS estimations - Average schooling fees and enrolment - Municipality level. Robustness check accounting for spatial autocorrelation

Dependent variable : Pupils per 100 inhabitants												
Spatial standard errors:	25 km radius			50 km radius			75 km radius			100 km radius		
	≤631 (1)	≥631 (2)	≤2 000 (3)	≤631 (4)	≥631 (5)	≤2 000 (6)	≤631 (7)	≥631 (8)	≤2 000 (9)	≤631 (10)	≥631 (11)	≤2 000 (12)
Population:												
Average schooling fees	-0.016** (0.007) [0.006]	-0.009*** (0.003) [0.002]	-0.007** (0.004) [0.003]	-0.016*** (0.007) [0.006]	-0.009*** (0.003) [0.002]	-0.007** (0.004) [0.003]	-0.016*** (0.007) [0.006]	-0.009*** (0.003) [0.002]	-0.007** (0.004) [0.003]	-0.016*** (0.007) [0.005]	-0.009*** (0.003) [0.002]	-0.007** (0.004) [0.003]
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	965	859	1709	965	859	1709	965	859	1709	965	859	1709

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Heteroskedasticity-robust standard errors (White standard errors) are reported in brackets. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 1.A17: Average schooling fees and enrolment. Municipality level. Robustness check on protestant influence

	Dependent variable : Pupils per 100 inhabitants		
	(1) Population ≤631 (Med)	(2) Population ≥631	(3) Population ≤2 000
Average schooling fees	-0.017*** (-2.779)	-0.011*** (-4.107)	-0.008*** (-3.147)
Percentage of Protestants - 1861	-0.049 (-1.072)	-0.005 (-0.223)	-0.035 (-1.010)
Demographical and geographical controls	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes
Department wealth controls	Yes	Yes	Yes
Department fixed effects	No	No	No
District clusters	39	59	57
Observations	883	759	1540
R^2	0.511	0.736	0.637

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *Average schooling fees* is computed in cents of franc as the mean value of fees within each municipality. When only the minimum and maximum values were specified for a given school, the average value in this school was taken as the mean between these two extreme levels.



Figure 1.B6: Fiscal areas in *Ancien Régime* France

Source: Administration fiscale du Royaume de France 1732

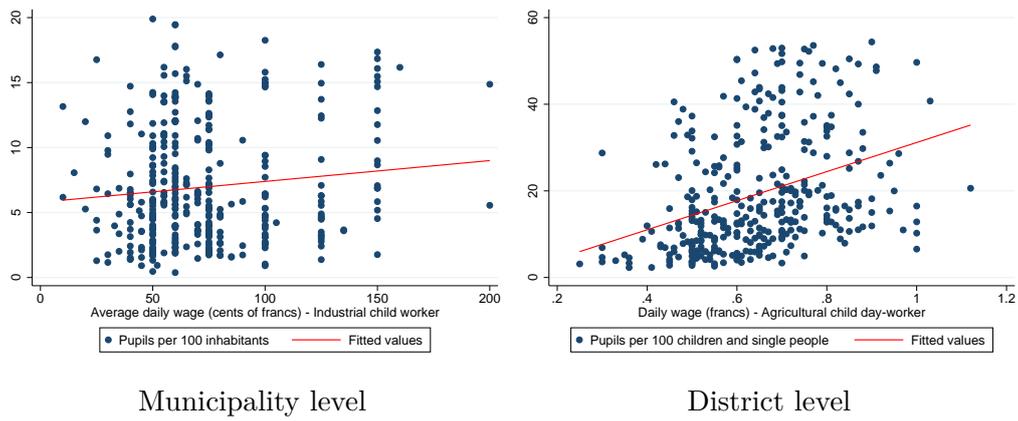


Figure 1.B7: Enrolment and child wages in industry and agriculture

Source: Guizot, industrial and agricultural surveys.

Public Education, Teaching Conditions and Human Capital Accumulation

Table 1.A18: Teaching certificates and public primary schooling - Logit, odds-ratios

	(1)	(2)	(3)	(4)	(5)
	Subsidised school	Fixed salary	Accommodation	Classroom	Other municipal occupation
First-degree certificate	0.775 (-0.397)	2.720** (2.053)	1.787 (1.509)	1.408 (0.681)	2.061* (1.889)
Second-degree certificate	2.109*** (3.927)	2.662*** (5.511)	2.029*** (3.934)	1.550** (2.331)	1.774*** (3.166)
Third-degree certificate	1.726*** (3.595)	1.585*** (3.105)	1.118 (0.726)	1.160 (0.931)	1.662*** (3.155)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	74	74	73	73	74
Observations	4052	4098	3604	3604	4076
Pseudo- R^2	0.345	0.243	0.272	0.295	0.287

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Certification degrees' impact is evaluated compared to the situation in which the teacher had no certificate. The salary amount is in francs per year.

Table 1.A19: Public primary schooling and teaching characteristics - Logit, odds-ratios

	(1)	(2)	(3)	(4)	(5)
	Order	Discipline	Work	Teaching	Progress
Subsidised school	1.415** (2.107)	1.455** (2.408)	1.671*** (3.684)	1.543*** (3.164)	1.341*** (2.704)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	73	71	73	74	74
Observations	3703	3377	3371	3570	3544
Pseudo- R^2	0.036	0.038	0.048	0.053	0.042

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *Subsidised school* is a binary variables which is equal to one if the municipality was investing in the school at stake. *Order*, *Discipline*, *Work*, *Teaching* and *Progress* are all binary variables taking the value to one when the school was controlled by the teacher for what regards order, discipline and work, when his teaching was deemed satisfactory and when pupils were making progress.

Table 1.A20: OLS estimations - Public primary schooling and teaching characteristics. Robustness check accounting for spatial autocorrelation

Spatial standard errors:	25 km radius		50 km radius		75 km radius		100 km radius	
	Teaching (1)	Progress (2)	Teaching (3)	Progress (4)	Teaching (5)	Progress (6)	Teaching (7)	Progress (8)
Average schooling fees	0.094*** (0.027) [0.027]	0.068** (0.027) [0.027]	0.094*** (0.027) [0.027]	0.068** (0.027) [0.027]	0.094*** (0.027) [0.026]	0.068** (0.027) [0.027]	0.094*** (0.027) [0.026]	0.068** (0.027) [0.027]
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipal population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3570	3544	3570	3544	3570	3544	3570	3544

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ *Source*: see main text.

Notes: Heteroskedasticity-robust standard errors (White standard errors) are reported in brackets. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 1.A21: Progress of pupils and municipal grants

	Progress of pupils				
	(1)	(2)	(3)	(4)	(5)
Fixed salary	0.100*** (4.200)	–	–	–	–
Salary amount	–	0.035*** (3.459)	–	–	–
Accommodation	–	–	0.110*** (5.326)	–	–
Classroom	–	–	–	0.089*** (3.701)	–
Other municipal occupation	–	–	–	–	0.005 (0.200)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	74	69	73	73	74
Observations	3599	2347	3146	3146	3562
R^2	0.060	0.069	0.067	0.064	0.053

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: All independent variables, except the salary amount, are binary which equal one when the schools was provided with grants. The *salary amount* is defined in tens of francs to facilitate the interpretation. *Progress of pupils* is taking value one if pupils were deemed to progress by the inspectors.

Table 1.A22: Progress of pupils and municipal grants - Logit, odds-ratios

	Progress of pupils				
	(1)	(2)	(3)	(4)	(5)
Fixed salary	1.532*** (4.121)	–	–	–	–
Salary amount	–	1.200*** (3.617)	–	–	–
Accommodation	–	–	1.595*** (5.322)	–	–
Classroom	–	–	–	1.468*** (3.677)	–
Other municipal occupation	–	–	–	–	1.023 (0.215)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	74	68	73	7	74
Observations	3599	2344	3146	3146	3562
Pseudo- R^2	0.046	0.053	0.051	0.049	0.041

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: All independent variables, except the salary amount, are binary which equal one when the schools was provided with grants. The *salary amount* is defined in tens of francs to facilitate the interpretation. *Progress of pupils* is taking value one if pupils were deemed to progress by the inspectors.

Table 1.A23: Teachers' characteristics and teaching certificates - Logit, odds-ratios

	(1)	(2)	(3)	(4)	(5)
	Order	Discipline	Work	Teaching	Progress
First-degree certificate	1.479 (0.791)	1.223 (0.409)	1.742 (1.130)	5.679*** (3.328)	3.874** (2.547)
Second-degree certificate	2.497*** (4.985)	2.302*** (4.201)	3.395*** (7.034)	4.926*** (8.396)	3.585*** (7.356)
Third-degree certificate	0.880 (-0.833)	0.835 (-1.039)	1.093 (0.579)	1.784*** (3.538)	1.239 (1.438)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes
District clusters	73	71	73	74	74
Observations	3787	3467	3457	3652	3621
Pseudo- R^2	0.067	0.066	0.082	0.088	0.078

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: *Order*, *Discipline*, *Work*, *Teaching* and *Progress* are all binary variables taking the value to one when the school was controlled by the teacher for what regards order, discipline and work, when his teaching was deemed satisfactory and when pupils were making progress. All independent variables are binary, taking the value one if the teacher had a certificate.

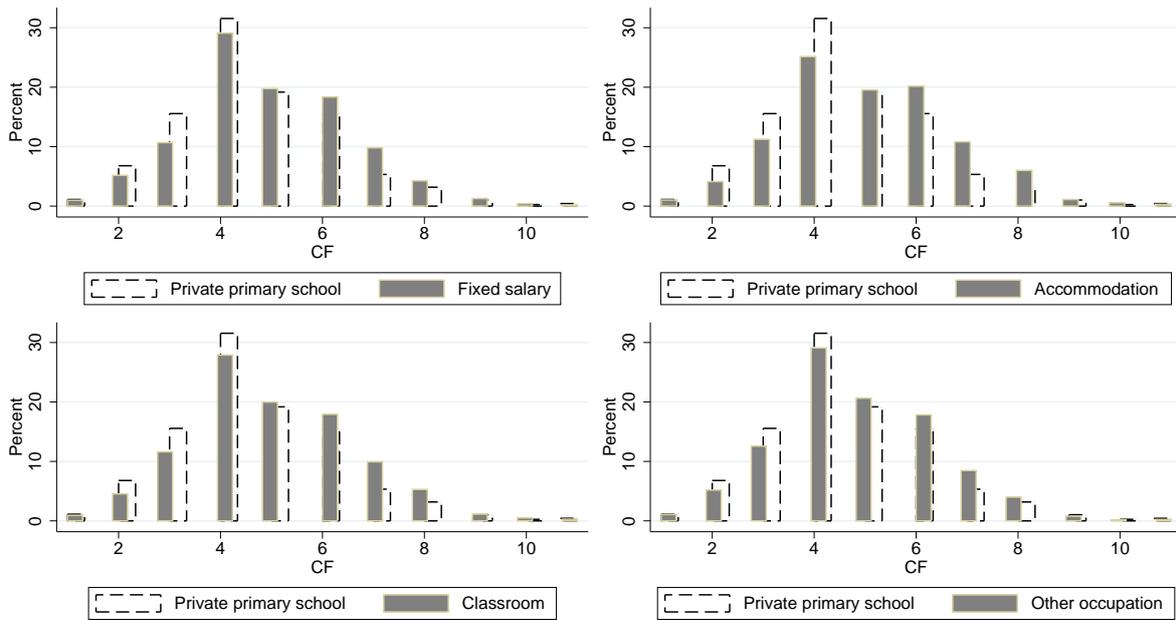


Figure 1.B8: Public schooling and number of subjects - Histograms

Source: Guizot survey.

Notes: Each bar in the histograms represents the percentage of observations corresponding to a given number of subjects taught. Therefore, it represents the percentage of primary schools for each number of subject. The schools are divided between those which were granted with public subsidises and the private ones. Each subsidy histogram is therefore compared to the same histogram of subjects but drawn only for private schools.

Table 1.A24: Public education and subjects taught. Mean t-tests

	N	Mean	N	Mean	p-value
Number of subjects	Private school		Public school		
	1163	4.56	4355	4.83	0.000
	No fixed salary		Fixed salary		
	2452	4.59	3128	4.89	0.000
	No accommodation		Accommodation		
2614	4.57	2350	5.05	0.000	
No classroom		Classroom			
2146	4.60	2818	4.94	0.000	
No other occupation		Other occupation			
3010	4.74	2530	4.78	NS	

Source: Guizot survey.

Notes: In private schools, there were around 4.6 subjects taught against approximately 4.8 in their public counterparts. The difference between the two is significant at a one-percent level.

Table 1.A25: Public education and years of schooling. Mean t-tests

	Private school		Public school		p-value
	N	Mean	N	Mean	
Years of schooling	1116	3.92	4350	5.28	0.000
	2390	4.41	3157	5.43	0.000
	2554	4.28	2362	5.61	0.000
	2071	4.07	2845	5.54	0.000
	2936	4.37	2563	5.64	0.000

Source: Guizot survey.

Notes: In private schools, pupils spent on average around 4 years at school against approximately 5.3 years in their public counterparts. The difference between the two is significant at a one-percent level.

Table 1.A26: Public education and subjects. Mean t-tests

	Private school		Public school		p-value
	N	Mean	N	Mean	
Arithmetic	1166	69	4344	61	0.000
Grammar	1166	38	4344	46	0.000
Spelling	1166	35	4344	53	0.000
Geography	1166	10	4344	7	0.000
Land surveying	1166	5	4344	11	0.000
Linear drawing	1166	4	4344	8	0.000
History	1166	4	4344	3	0.058
Music	1166	2	4344	4	0.010

Source: Guizot survey.

Notes: Arithmetic was taught in around 69% of the private primary schools for which information on subjects and subsidies is available. It was the case in 61% of the public schools. The difference between the two is significant at a one-percent level.

Table 1.A27: Public schooling and human capital accumulation - Logit, odds-ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Arithmetic	Grammar	Spelling	Geography	Land surveying	Linear drawing	History	Music
Subsidised school	1.569*** (2.982)	1.565*** (3.788)	1.635*** (3.488)	1.445 (1.379)	1.155 (0.505)	2.738** (2.489)	1.824 (1.603)	0.708 (-0.663)
Demographical and geographical controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industrial controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District clusters	70	70	70	59	63	62	49	38
Observations	3732	3732	3732	3237	3613	3621	3050	2631
Pseudo- R^2	0.150	0.126	0.216	0.140	0.136	0.108	0.175	0.231

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Note: All subject names correspond to binary variables taking value one if the subject was taught in the primary school.

Table 1.A28: OLS estimations - Public schooling and human capital accumulation. Robustness check accounting for spatial autocorrelation

Spatial standard errors:	25 km radius		50 km radius		75 km radius		100 km radius	
	Subjects	Schooling years	Subjects	Schooling years	Subjects	Schooling years	Subjects	Schooling years
Number of:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Subsidised school	0.344*** (0.077) [0.075]	0.289*** (0.072) [0.086]	0.344*** (0.077) [0.070]	0.289*** (0.072) [0.096]	0.344*** (0.077) [0.071]	0.289*** (0.072) [0.103]	0.344*** (0.077) [0.071]	0.289*** (0.072) [0.107]
Demographical and geographical controls	Yes							
Industrial controls	Yes							
Municipal population controls	Yes							
Department fixed effects	Yes							
Observations	3732	3628	3732	3628	3732	3628	3732	3628

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: see main text.

Notes: Heteroskedasticity-robust standard errors (White standard errors) are reported in brackets. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.



Chapter 2: Industrial activities and primary schooling in early nineteenth-century France

Abstract

This article investigates the impact of industrial activities on primary instruction in early nineteenth-century France. To do so, I use a newly constituted database on the location and characteristics of primary schools at the level of municipalities. This database is extracted from the Guizot Survey conducted in 1833, before the implementation of the first national law making the opening of a school mandatory in any municipality more than 500 inhabitants. By using mineral deposits as an instrument, I first show that the presence of industrial activities in a given municipality was positively influencing the presence of primary schools. An increase in the supply of schools by municipalities explains this association. Additional resources transferred to them by manufactures favoured this increase through an income effect. However, I find no significant link between industry and the accumulation of human capital. On the contrary, I provide indications that industrial activities were associated with lower enrolment rates. If they had a positive impact on the demand for schooling, it was only for a very restricted part of the population.

1 Introduction

In economic history, the impact of industrialisation on education has been greatly debated. It has been argued, in the British case for example, that early industrialisation and the progressive introduction of large-scale factories using steam-power were mainly skill-saving. They favoured the development of low-skilled jobs and the fall in semi-skilled blue-collar jobs such as weavers, shoemakers or tailors (de Pleijt and Weisdorf, 2016), possibly diminishing the demand for instruction and literacy rate in England (de Pleijt, 2018). This was especially true if steam engines were favouring the use of machines on which children were performing secondary tasks in assisting older workers, as putting together broken pieces of thread on spinning mules in the textile sector (Nardinelli, 1980), (Nardinelli, 1990). This came under the name of the "deskilling hypothesis" (Sanderson, 1972), (Nicholas and Nicholas, 1992). The same observation has been made on the level and growth of secondary instruction in the United States (Goldin and Katz, 1997). This negative effect of industrial activities on literacy rates was also identified in the French case. In the Nord department, for example, industrial districts were found to be characterised by relatively low literacy rates between 1831 and 1843 (Leblond, 1970). By the same token, the presence of a developed textile sector was correlated with a lower literacy in the diocese of Rouen at the end of the 18th century (Furet and Ozouf, 1977b).

However, industrialisation and technical changes may also have led to a rise in the demand for some medium and high-skilled workers (Feldman and van der Beek, 2015), (de Pleijt et al., 2018), especially during its second phase (Mokyr, 1993)⁸⁶. Moreover, in the English or French cases, it is not obvious to show that industrialisation was the very cause of a fall in literacy rate (Schofield, 1973), (Corbin, 1975), all the more since a sharp increase in this rate took place at the beginning of the nineteenth century, precisely at the time when industrial activities surged (Laqueur, 1974). Controlling by Irish immigration also diminishes the scope of the argument in the British case (West, 1978). Therefore, the higher demand for low-skill workers, caused by the industry, may not have affected greatly literacy as it wasn't inducing people previously sending their children to school to stop doing so.

In the case of France, there seems to have been a complementarity between technology and human capital. Franck and Galor, 2017, found that the number of steam engines at the department level in 1839-1847 influenced strongly human capital accumulation in the early phase of industrialisation. A larger number of steam engines had a significant impact on the number of teachers later in the century, on the share of apprentices in the population, on the share of literate conscripts, on the number of schoolhouses and on the number of pupils enrolled in primary schools relative to the number of inhabitants. Similarly, Diebolt et al., 2017a found that the number of steam engines within departments was positively associated with literacy rates and primary schools' presence in the first part of the nineteenth century. The association became non-significant after 1850 and a positive relation emerged with adult education and superior primary schools, the level of education subsequent to primary schooling strictly speak-

⁸⁶See (Katz, 2016) for an illustration in the American context.

ing⁸⁷. More generally, the positive influence of industry may have been due to an income effect on the supply and demand for schooling, to a higher demand for skills within the factories, or to the will of manufacturers to enhance discipline within the workforce.

In this article, I adopt a different approach in order to evaluate how industrial activities influenced primary schooling in early nineteenth-century France, at the beginning of French industrial era. I do so by testing the effect of the presence of industrial factories on the supply and demand of primary schooling at the level of municipalities. I focus on manufactures more than ten workers and not on proto-industrial activities. This level of disaggregation will help to understand in concrete terms the relationship between the two phenomena and its transmission channels. I use a newly constituted database on education at the level of municipalities in this work. This database is extracted from a national survey launched by French Minister of Education François Guizot in 1833. The survey, conducted in every primary school of every French municipality, provides very precise information on the characteristics of schools, teachers and municipal investment in education. I collected the data at the municipal level for 22 departments, which amounts to 8 129 towns and villages, a primary school being located in 59.5% of them.

I test the influence of industrial activities on primary schooling first by using a simple OLS framework. Indeed, the onset of industrialisation in France was linked to upper-tailed knowledge influencing positively the adoption of modern technology, this knowledge being uncorrelated with basic indicators of literacy (Squicciarini and Voigtländer, 2015). Therefore, even if the issue of reverse causality cannot be utterly ruled out, since basic education has been shown to have positively influenced industrialisation in Prussia for example (Becker et al., 2011), it doesn't constitute the major concern about the validity of least squares estimators. More worryingly, a third factor like wealth coming from trade or agriculture may have influenced both the presence of schools and factories. Therefore, to deal with this potential omitted variable bias, I use data on the location of ore to instrument the presence of industrial manufactures. This location was linked to mining activities which depended by definition directly on mineral deposits. Moreover, these activities could have also attracted other industrial sectors, as the production of metal objects and tools or the production of clothes, interested in benefiting from the outlet constituted by the presence of mines.

First, I show that the presence of industrial manufactures influenced positively and significantly the location of primary schools, both in the OLS and the IV estimations. This effect was, as expected, greatly due to mining activities when using the instrumental variable technique. It was also greater in magnitude for larger manufactures, namely those more than 20 workers. An increase in the supply of primary schools by municipalities accounted for this association. Industrial activities, through taxes applied on their production, contributed to increase the economic resources of municipalities. This enabled them to invest more intensively in primary schooling.

Before the Guizot Law, municipalities had no legal obligation to invest in primary instruction.

⁸⁷This level corresponds to what is called "secondary education" nowadays.

Schools could be totally funded through fees (known as the *écolage*) paid by parents, partly by the fees and municipal grants and solely by municipalities⁸⁸. The school was said to be private in the first case, public in the last two of them. Paying teachers on a fixed annual basis and providing them with a classroom or an accommodation were the three main types of municipal grants. The impact of industrial activities on the supply of school was therefore due to an increase in the provision of public primary schools.

Indeed, I provide indications that these activities were not associated with a higher demand for schooling and accumulation of human capital. Enrolment rates were on average lower in municipalities with factories, especially if these factories belonged to sectors whose workforce was constituted by a large share of children. I also find a positive correlation between the presence of industry and the number of subjects taught within schools. However, even if manufactures prompted this extension of education, it remained restricted to a very limited number of pupils. Therefore, industrialisation, in its initial phase, had either no or a negative impact on the extensive margin of human capital accumulation, and only at best a slightly positive effect on its intensive margin.

This analysis adds to the debate about the influence of early industrialisation on education in two ways. First, it focuses on France, a country much less studied than England from that perspective. Second, thanks to data collected at the municipal level and to the use of deposits as an instrument, I can estimate the causal impact of industrial activities on schooling. This impact was positive for what regards the supply of (public) schools, but flat or negative on the demand for schooling.

The next section presents some historical facts about primary schooling and industrial activities from the Revolution to the Guizot Law of 1833 and helps to contextualise and to specify the study. Section 3 is a description of the data I use while Section 4 presents the research methodology adopted. Econometric results are presented in Section 5 for what regards the presence of primary schools and transmission channels are studied in Section 6. In Section 7, the influence of industrial activities on human capital accumulation is presented. Section 8 concludes.

2 A Differentiated Development of Primary Schooling and Industrial Activities

The Guizot Law was passed on the 28th of June 1833, making compulsory for any municipality over 500 inhabitants to open and maintain a primary school for boys. Teachers were also to be paid on a regular basis, not less than 200 francs a year. This law was the first major step towards universal schooling undertaken in France. To this date, the decision to open a primary school (along with paying the teacher on a fixed basis or not, how much, buying books, blackboards and other pieces of furniture, providing the teacher with an accommodation or a

⁸⁸This last case in which parents could benefit freely from a schooling service was extremely rare at the beginning of the nineteenth century.

classroom,...) was mainly made at the level of municipalities⁸⁹. Local authorities thus played an important role, along with parents who were in most cases (except when they were listed as indigents by the municipality or when the school was totally free, which was extremely rare at that time) paying fees so that their children could attend school.

At the state level, many reforms took place during the French Revolution to legislate on primary schooling⁹⁰. The major orientations of the reforms were to separate instruction from religious influences, to create a distinct teaching for boys and for girls and to grant people with free and universal education. However, the effect of the revolutionary period on education remained small, mainly due to a lack of financial means and to the difficulty to legislate in an unstable political context (Mayeur, 2004). This evolved under the Restoration. From the 29th of February 1816, a written certification of morality was mandatory in order to teach, this certification being delivered by the mayor and the parish priest. The capacities of teachers were also to be checked by a civil servant. A certificate composed of three different degrees, the third one being the lowest on the hierarchy, was from then on a prerequisite for teaching. However, this was also rarely fully applied⁹¹. Indeed, examinations often took place after the nomination of teachers. If they were unable to pass the tests, authorities should have refused them the certificate and close the school, a measure which was unlikely to be implemented (Prost, 1968).

In this context, primary schooling developed differentially across regions. From the early work of the Dupin baron, an opposition has been drawn between a well-educated France above the Saint-Malo/Geneva line and a less-educated one below (Dupin, 1826)⁹². For example, in the 1820s, the enrolment per 100 children six to thirteen years of age was higher north of the line, with a mean of 94, compared to south of it, with an average level of 53. This was also true for the schooling of girls (Grew and Harrigan, 1991). Figure 2.1 depicts this distinction between French departments. Controlling by the age structure doesn't change much the results⁹³. Therefore, before the Guizot Law, primary schools and high enrolment rates were mostly concentrated in the north-east part of France, even if some other regions as the Rhône Valley and the Gironde were also characterised by rather good schooling levels.

⁸⁹A precise description of the daily life of schools and teachers in the eighteenth and early nineteenth centuries can be found in (Duveau, 1957). Analyses or testimonies on the state of primary schooling by teachers from the early nineteenth century are available in (Lorain, 1837) and (Meunier, 1981). In order to have an analysis of local schooling development in the eighteenth century, see for example (Vovelle, 1975) or (Laget, 1971). See (Gildea, 1983) for a local study from 1800 onwards for the departments of Ille-et-Vilaine, Gard and Nord.

⁹⁰In order to have a full political analysis and a description of the laws, projects, and debates about primary instruction during this period of time, one can refer to (Gontard, 1959) and the second and third chapters in (Furet and Ozouf, 1977a).

⁹¹See (Nique, 1990) to have a description of educational state measures from 1815 onwards.

⁹²This analysis has been partly contested as it didn't take into account the age structure of the population (Fleury and Valmary, 1957).

⁹³This is done in Figure 2.B1 in the Appendix. Educational characteristics are displayed at the department level in these maps, while the analysis is at the municipal level. This is done for the sake of simplicity and clarity in the presentation of the data on education, or industry.

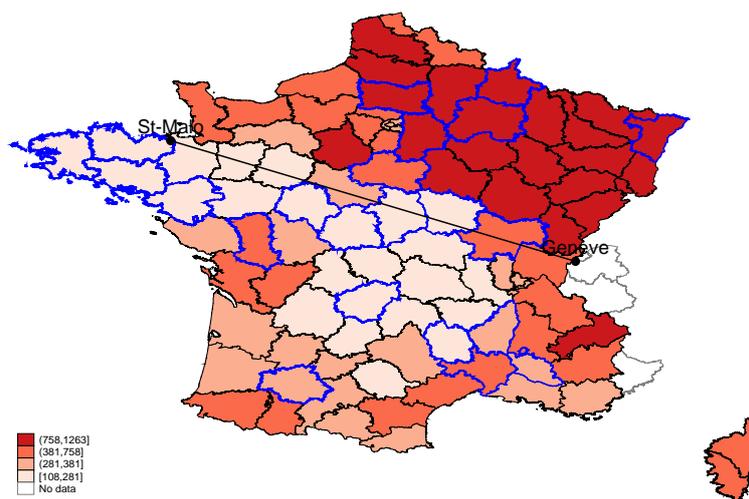


Figure 2.1: Number of pupils attending primary schools - winter 1833 (over 10 000 inhabitants)

Source: Statistique générale de la France, Guizot survey - Report to the King.

Note: Departments in blue are the ones for which education data are available at the level of municipalities.

As reported in Figure 2.2, the spread and geographical distribution of industrial activities in 1839-1847 differed from the one of primary schooling. Manufactures were mostly concentrated in the north-west and western departments close to the Atlantic Ocean. This concentration was associated to the volume of commercial activities in Atlantic ports like Le Havre, La Rochelle or Nantes (Asselain, 1984). Manufactures more than 20 workers (along with the number of steam engines and the number of industrial workers) were more concentrated in the north and north-eastern parts of France, along with the Rhône Valley. This was associated to the progressive surge of mining and metallurgic sectors in France at that time, in particular to the exploitation of coal and iron. Deposits were indeed highly concentrated in the Nord-Pas-de-Calais, Lorraine, Auvergne, Loire, Dauphiné, Provence and Cévennes areas in France. In some regions as Normandie or the Dauphiné, the concomitant presence of rivers, forests and deposits explains the ancient presence of metallurgic sectors (Léon, 1948), (Richard, 1962), (Kellenbenz, 1963). Textile activities also followed closely this geographical pattern (Dunham, 1953). The concentration of industrial activities in the north and north-eastern parts of France was also influenced by the Continental Blockade established by Napoleon. The textile sector, and cotton industries in particular, benefited of the protection from British competition to develop massively in these areas during the Napoleonic wars. The industrial dynamism of Belgium and the Roer, integrated within the French Empire, also influenced the location of factories within close French regions (Crouzet, 1964).

The early nineteenth century is the time period of the first industrialisation in France. Food industry and textile were the leading sectors. Each of them accounted for one-third of the total industrial product, steel industry for one-tenth. Industrial production growth rates began to surge at that time, being superior to 3% for the best years from 1815 onwards (Lévy-Leboyer, 1968). Previously, they had been at a level of around 0.5% between 1781-1790 and 1803-1812 (Crouzet, 1996). The highest rates were attained at the end of the July Monarchy and under

the Second Empire (Crouzet, 1970). This growth remained however quite gradual all over the century, which led some authors to deny the idea of a real industrial take-off in France (Mendels, 1972)⁹⁴.

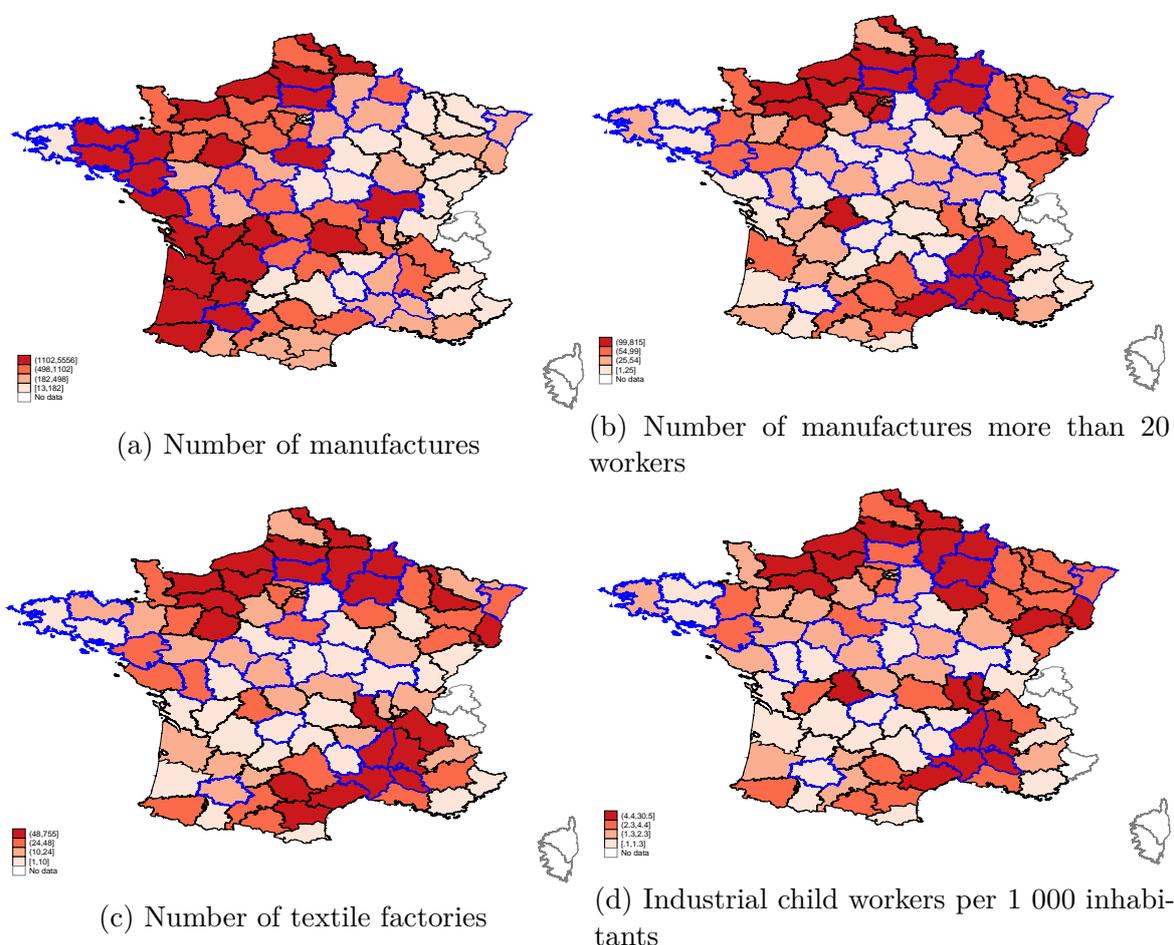


Figure 2.2: Industrial activities in France, 1839-1847

Source: Industrial survey.

Note: Departments in blue are the ones for which education data are available at the level of municipalities.

⁹⁴This idea, along with the level of industrial performance of the French economy, have been greatly debated. They have been deemed low and stagnating compared to Great-Britain in the 1940s and 1950s, before a revisionist literature insisted on the relatively good economic performance of France during the 19th century and on the distinctive path of growth this country followed (Crouzet, 1966), (O'Brien and Keyder, 1978). This point of view has subsequently been qualified by authors amending the figures on French productivity growth and insisting anew on the difficulties known by the agricultural and industrial sectors compared to the British ones (Crafts, 1977), (Crafts, 1984). See (Lévy-Leboyer, 1978) for an analysis of French industrial investment and (Lévy-Leboyer and Bourguignon, 1985) for a macro-economic analysis of French economy along the century. See (Crouzet, 2003) for a historiography of French economic growth during the 19th century, from the "retardation-stagnation" thesis to the "moderate revisionism". To have an economic analysis and description of the industrialisation period in France and other European countries over the century, see (Braudel and Labrousse, 1976), (Verley, 1999) and (Verley, 1997). For an analysis of the French case under the *Ancien Régime*, see for example (Sée, 1925) or (Woronoff, 1998).

3 Data

3.1 Data on Education

In 1833, when the Guizot Law was passed, a survey at the national level was conducted in order to evaluate the state of primary schooling in France, under the supervision of Guizot⁹⁵. 490 inspectors were sent throughout France in autumn 1833. All primary schools, both public and private, were to be examined. However, primary schools to which only girls were attending were excluded from the scope of the survey as the Guizot law didn't apply to them. All departments were inspected, except Corsica.

Data coming from the Guizot Survey of 1833 was published for all French districts in a *Report to the King* (Guizot, 1834). These districts (*arrondissements départementaux* or *sous-préfectures*) correspond to an administrative subdivision of departments (counties). Two to six of them existed in each department. Only some of the questions asked in the initial survey, those deemed of major interest, were aggregated in this report. From the initial individual (at the level of each primary school) forms, the data was collected for 22 departments and 8 129 municipalities⁹⁶. At least one primary school was present in 4 836 of them (59.5%). This project has been initiated by the *Service d'Histoire de l'Éducation* of the I.N.R.P, which collected data for the academies of Nantes, Bourges and Nîmes. Other departments were then added to this initial database. In Figure 2.1, one can see that these departments (in blue) belong to areas with very different levels of enrolment. The Brittany region and the centre part of France with very low levels of enrolment are well represented in the sample. So are the highly educated north-east and the southern part of the country where education was more unevenly distributed, with five departments for each area. To sum up, around 20% of the departments above the St Malo-Geneva line are represented in the sample, against 25% of those below the line⁹⁷. This should ensure a high variation in terms of education and a good representativeness of the data used. Their collection was indeed conducted with the aim of catching all the determinants that underpinned primary schools spreading. This, added to the focus at the municipal level, should help avoiding some of the criticisms that were pronounced against the reliance of aggregated historical data on primary schools⁹⁸. Other data on education is coming from the *Statistique générale de la France*⁹⁹.

The departments selected are quite representative of France for what regards primary education and the industrial characteristics which will be under scrutiny in this analysis. Taking

⁹⁵A lot of information on this survey is available here : <http://www.inrp.fr/she/guizot/>.

⁹⁶These departments are: Ardèche, Ardennes, Cher, Corrèze, Côtes-du-Nord (Côtes D'Armor), Finistère, Gard, Gers, Indre, Indre-et-Loire, Loire-Inférieure (Loire Atlantique), Loiret, Lozère, Marne, Morbihan, Nièvre, Oise, Bas-Rhin, Saone-et-Loire, Seine-et-Marne, Deux-Sèvres and Vaucluse. At that time, there were 86 departments existing and 26 academies. Current denominations of departments are specified in brackets when a change occurred.

⁹⁷Excluding the three departments located on this very line.

⁹⁸See for example on this point the criticisms made in (Luc, 1986) and (Luc and Gavaille, 1987). See (Grew and Harrigan, 1986) for a reply and (Furet and Sachs, 1974) for a use of these data.

⁹⁹These data can be found here <https://journals.openedition.org/acrh/2890>

average values at the level of districts in order to compare this "municipal level sample" to the entire country thanks to the *Report to the King*¹⁰⁰ shows that the sample differs significantly only in the percentage of municipalities with factories (21.6% against 17.2% for France) when considering industrial factors. The number of workers, their average wages, the amount of industrial production or the presence of large factories (more than 20 workers, the top one-third in terms of size) didn't differ significantly between them. The same is true for the investment of municipalities in primary education (provision of a fixed salary or an accommodation to teachers) and for the number of primary schools. However, enrolment rates and the percentage of municipalities with schools (60.8% against 71.5% for France) are lower in the sample, which means that the departments at stake were less well-endowed in primary schools than at the national level. This is why several agricultural wealth controls, district and department fixed effects will be introduced in the estimations to reduce potential biases linked to district or department-specific factors¹⁰¹.

3.2 Data on Industrial Activities and Economic Resources

The economic data are coming from two surveys: the industrial survey of 1839-1847 and the agricultural survey of 1852¹⁰². The agricultural survey is used in order to control for the agricultural resources of districts. It can be held as relatively representative of the state of French agriculture in the middle of the nineteenth century (Demonet, 1990). The major issue with these data is the 20 years time-lapse that separates them from the Guizot survey. However, since agricultural characteristics were quite stable over time, they should still constitute a good approximation of the agricultural resources at the beginning of the nineteenth-century and serve as good controls for agricultural resources of districts.

Data on the location of factories as well as their characteristics are drawn from the industrial survey. These data are available at the level of municipalities, which makes it possible to match them with those on primary schools. The factories reported in the survey were composed of more than 10 workers in order not to be mingled with craftsmanship. The data coming from this survey are quite reliable. For example, the average daily wages reported are in compliance with those provided by Villermé, 1971, 1840 and comparable to those coming from other sources like the *Statistique générale de la France*. A comparison with the *Statistique de l'industrie minérale* also reinforces its reliability (Chanut et al., 2000). Data on industrial activities are therefore around ten years posterior to the ones on primary schooling. As a consequence, I have to assume

¹⁰⁰See in Table 2.A1 the Appendix.

¹⁰¹It is possible, for industrial and demographic characteristics, to directly compare data at the level of municipalities and factories. This is what is done in Table 2.A2 in the Appendix. This doesn't modify the global picture about the representativeness of the data used. Demographic characteristics exhibit the same differences than at the district level. It is true that the percentage of municipalities with large factories now differ significantly in the sample. However, the magnitude of the difference doesn't indicate that municipalities in the sample were characterised by highly more concentrated industrial activities. Industrial wages and taxes on industrial activities remain comparable between factories in the sample compared to France, which indicates that the factories present in the data are comparable to the "average factory" at the national level.

¹⁰²More information on them can be found in (Chanut et al., 2000) for the industrial one, in (Marin and Marraud, 2011b) and (Demonet, 1990) for the agricultural one.

that the location of factories remained stable during this time period. Unfortunately, no data at the level of municipalities prior to this date are available to support this hypothesis. However, I will focus mostly on large factories which were more likely to remain stable in their location over the ten-year gap. This will enable me to compare the presence of industrial activities to the one of primary schools with more confidence.

3.3 Demographical Data on Municipalities

Data on the population of municipalities is taken from the *Statistique générale de la France* for the years 1793 and 1836. Population dispersion is taken from the Postal Survey of 1847 along with the surface area of municipalities which have disappeared or merged since 1833¹⁰³. Since this survey is posterior to the Guizot one, I have to assume that population remained stable over the fourteen years separating them, which seems to be a quite reasonable assumption. The *Institut national de l'information géographique et forestière*, a public organism in charge of the diffusion of geographic information in France, provides surface data for the other municipalities. The altitude of municipalities is also taken from this organism.

3.4 Descriptive Statistics

Descriptive statistics are displayed in Table 2.1¹⁰⁴. Primary schools were located in 59% of the municipalities in the data. Around 39% of them were paying teachers a fixed annual salary. This salary was varying a lot, between 2 and 5 450 francs per year. Municipal salaries were often low compared to the minimum level of 200 francs implemented by the Guizot Law, as 50% of them were concentrated below this threshold. Generally speaking, around 47% of the municipalities were subsidising primary schools. Industrial factories were present in 12% of the municipalities, those more than 20 workers in 6% of them. The majority of manufactures, 62.6%, were less than 20 workers (1 545 factories over the 4 128). I will take this number of workers as a threshold and define the top third as large factories¹⁰⁵. The average population of the municipalities was around 990 inhabitants, but 50% of them were less than 631 inhabitants and 90% less than 2 000. Population dispersion could be high within municipalities as the average scattering was around 47%, with a median value close to 50%.

¹⁰³More information on this survey is available in (Marin and Marraud, 2011a).

¹⁰⁴Descriptive statistics on agricultural controls are present in Table 2.A3 in the Appendix.

¹⁰⁵Taking 30 workers or 40 workers as a threshold wouldn't change the results of the paper. This would amount to select 44% and 39% of the municipalities with industrial activities as characterised by the presence of large factories. However, above 40 workers, the restriction applied to industrial variables make the analysis unreliable using the instrumental variable strategy presented in section 4.1.

Table 2.1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Primary School	0.59		0	1	8129
Fixed salary	0.39		0	1	8129
Salary amount - francs per year	247.1	222.4	2	5449.5	3190
Public school	0.47		0	1	8129
Pupils per 100 inhabitants	9.5	6.8	0.3	61.6	4658
Number of subjects	4.6	1.7	1	11	4835
Schooling years	5.3	1.9	1	11	4629
Percentage of population scattered	46.8	35.6	0	100	6941
Population - 1833	989.8	1811.9	30	75895	8064
Population - 1793	823.3	1684.2	22	80000	7968
Surface area - hectares	1725.5	1439.1	8	18359	7844
Average altitude - meters	207.7	194.6	1	1399	7844
Factory	0.12		0	1	8129
Factory more than 20 workers	0.06		0	1	8129
Number of factories	0.5	8.5	0	699	8129
Taxes on industrial activities - francs per year	84.6	1164.1	0	77445	8129
Industrial male worker daily wage - cents of francs	210.7	74.3	40	500	930
Industrial female worker daily wage	96.1	34.2	20	300	466
Industrial child worker daily wage	71.8	30.5	10	200	503
Percentage of industrial child workers	11	13.9	0	66.7	933

Source: Guizot, agricultural, industrial and postal surveys. IGN data and *Statistique générale de la France*.

Notes: All variables are defined at the municipal level. For example, the number of factories is equal to the average number of manufactures present in a municipality.

4 Research Methodology

4.1 Econometric Model

In this work, I focus on the beginning of the nineteenth century for three reasons. First, after 1833, the relation between industrial activities and education could be biased by the impact of the Guizot reform. Second, no data at the municipal level are available further back in time. Thirdly, since industrialisation began in the early nineteenth century in France, it would make less sense to study its interaction with primary schooling before this time period. This may be seen as an issue as schools might have been created before economic activities developed. However, even if it were the case, one must remember that teachers were highly dependent on fees paid by families and on the potential financial help provided by municipalities. Thus, if

these municipalities were not able to support them or parents not able to pay fees, teachers could be forced to move in another area. This was entailing the disappearance of the school. In the autobiography of (Meunier, 1981), a teacher from the Eure-et-Loire department, this precariousness of teaching appears clearly, especially at the beginning of his career during which he remained an itinerant teacher. Later on, when several schools were created in the municipality in which he was settled, the battle teachers were all engaged in to attract children and benefit from fees made their activity unstable¹⁰⁶. Therefore, at some point, a sufficient amount of wealth was needed either to create a primary school or to maintain it. The estimations will capture both effects: either the direct effect of industrial activities on the creation of schools or the indirect one on their maintaining.

As seen before, the pattern of education differed from the industrial one at the level of French departments. Therefore, there is *a priori* no strong reason to believe that primary schools were influencing manufactures location at the beginning of the nineteenth century contrary to the Prussian case (Becker et al., 2011). This location was more dependent on the proximity of deposits, commercial networks, canals, royal roads, ... It is true that manufacturers may have wanted to settle in municipalities with no school where children would be more available to work within factories and at a cheaper cost. However, this assumes that the implementation of a factory willing to employ children was not sufficiently attractive to divert them from the school. As presented in section 7, I find a negative correlation between industrial activities and enrolment rates. This tends to indicate that manufacturers had little trouble finding children to work within their factories, even when a school was present in the same municipality. Moreover, enrolment rates were often low at the beginning of the nineteenth-century, in link with the high reliance of families on children's financial support (Villermé, 1971, 1840). Therefore, it is unlikely that a school would attract the majority of the children, so that a manufacturer willing to settle in this municipality would find only a few of them to be employed. Also, in the French case, early industrialisation was shown to have been more dependent on upper-tail knowledge than on the average literacy, especially for what regards the implementation of modern sectors (Squicciarini and Voigtländer, 2015)¹⁰⁷. Therefore, even if some manufacturers may have searched for a disciplined workforce and therefore for schools (Rosanvallon, 1985), (Johnson, 1970), it is hard to imagine that this influenced greatly the location of industrial activities.

However, industrial activities and primary schools' location may have been both driven by a third factor. Resources coming from trade or agriculture for example could have prompted the creation of schools and the development of industrial production. As a consequence, the estimation of the relation between industry and schooling is subject to a potential omitted variable bias. Therefore, I will instrument industrial activities by the presence of iron, coal and

¹⁰⁶The memoirs of Louis-Arsène Meunier were not published until 1981. He lived between 1801 and 1887.

¹⁰⁷See also (de Pleijt and van Zanden, 2016), (Mokyr, 2005), (Baten and van Zanden, 2008) and (Allen, 2003) for a global analysis at the European level, (Mitch, 1993) for the British case. This latter estimated that, in 1841, only 4.9% of men and 2.2% of women in England were employed in jobs where literacy was absolutely required. Around half of men were employed in jobs where it had nearly no chance of being useful.

copper deposits. These latter constituted the three main types of ore that were exploited at the beginning of the nineteenth century. They were highly concentrated in the eastern, central and southern-central parts of France, along with the mountainous lands of the Pyrenees and the Alps¹⁰⁸. The number of deposits by department was varying between zero and 33, with an average level of 8 between French departments. Coal deposits were mostly located in Lorraine, Nord-Pas-de-Calais, Auvergne, Midi, Loire and Dauphiné regions. The high concentration of deposits in the centre part of France, in the Pyrenees and in the eastern departments was more closely linked to iron.

The second-stage estimation equation is the following:

$$School_{m,d} = \alpha_d + \beta_1 Industry_{m,d} + \beta_2 Demo_{m,d} + \beta_3 Agr_{arr,d} + \epsilon_{m,arr,d} \quad (2)$$

where $School_{m,d}$ is a dummy variable which equals one if a primary school was present in a given municipality m within a department d . α_d captures time-invariant fixed effects at the level of departments¹⁰⁹. For example, the fact of being close to the sea or to the frontier could entail a higher wealth for municipalities through trade activities. $Industry$ is a dummy variable which equals one if a factory (or a large factory) was present in municipality m , $Demo$ is a set of demographics and geographical variables defined at the municipal level. Agr is a set of agricultural variables defined at the level of districts. Standard errors indexed by arr are clustered at the district level. This is done in order to account for spatial correlation. Indeed, as the agricultural variables are defined at a more aggregated level than municipalities, not doing so could cause the standard errors to be seriously downward-biased and lead to spurious findings. This may happen if the micro units (the municipalities) share some unobservable characteristics in a given group (district) when the estimation is done either by OLS (Moulton, 1986), (Moulton, 1990) or using instrumental variables (Shore-Sheppard, 1996), (Hoxby and Paserman, 1998). For example, the long-term effect of Protestant settlement and the use of a patois were identified in the literature as having influenced schooling spread¹¹⁰.

For what regards demographic and geographic variables, I control by the average altitude of municipalities, their surface area, their total population in 1793 and by the share of their population that is considered to have been scattered. This last measure is coming from the postal survey and based on a simple contiguity criterion. It is expected to have influenced negatively primary schooling by increasing the distance from habitations to schools and therefore decreasing the number of pupils. Mountainous land is expected to have had the same effect. Population should, on the contrary, have increased the potential number of pupils and the resources municipalities could dedicate to education. I consider the population in 1793 to avoid the issue of "bad controls" (Angrist and Pischke, 2008). Indeed, I found a positive correlation between

¹⁰⁸See Figure 2.B2 in the Appendix.

¹⁰⁹I will also introduce fixed effects at the district level in the estimations instead of agricultural controls and department fixed effects. Since this work is cross-sectional, I don't introduce time-varying factors at these levels.

¹¹⁰See for example (Laget, 1971) on the Protestant influence in the Bas-Languedoc and (Furet and Ozouf, 1977a) on the influence of the Breton patois in the Morbihan.

population growth in 1793-1833 and the presence of industrial activities¹¹¹. Therefore, taking a measure of population 46 years anterior to the Industrial survey and prior to the industrial revolution in France helps avoiding the issue of bad controls. Surface area's effect is *a priori* less clear since it could have at the same increase distances from school and the amount of agricultural resources available.

Agricultural resources controls are the average agricultural land value, the percentage of day-workers family spendings dedicated to food consumption and the average agricultural area. Agricultural production organisation is also controlled for through the number of animals per inhabitants, the number of day-workers, of tenant-farmers and of share-croppers reported respectively to one-hundred self-employed and the average agricultural area per self-employed. This is done firstly in order to account for the potential employment of children as shepherds. Secondly, a high concentration of share-croppers and day-workers has been found to be closely linked to a relative impoverishment of agricultural workers in the literature (Furet and Ozouf, 1977b)¹¹².

The estimation framework of the first stage is :

$$Industry_{m,d} = \alpha_d + \beta_1 Instr_{m,d} + \beta_2 Demo_{m,d} + \beta_3 Agr_{arr,d} + \epsilon_{m,d} \quad (3)$$

where $Instr_{m,d}$ is a dummy variable taking the value one if a deposit was present in the municipality m , this deposit being exploited or not. This point is important as the use of mining activities as an instrument would violate the exclusion restriction. Indeed, coal mining, for example, increased child mortality and had a direct impact on the formation of human capital. On the contrary, the use of deposits potentially exploited by factories or not is exogenous as their presence had no direct influence on primary schooling. These data are coming from the *Bureau de Recherches Géologiques et Minières* which indexed the geographical coordinates of all the deposits in France and therefore the municipalities where these deposits were located. This instrument is therefore closely related to the proximity to rock strata from the Carboniferous era used by Fernihough and O'Rourke, 2014 or variations in this strata used by de Pleijt et al., 2018¹¹³.

The estimation will be done using a standard two-stage least squares technique. Indeed, as presented in (Angrist and Pischke, 2008) the use of a non-linear estimation tool, as Probit or

¹¹¹The demographic growth of municipalities with factories was 7% higher than the one of their counterparts between these two years. The difference remained significant even after controlling by other municipal characteristics and agricultural variables.

¹¹²See 148 in the Appendix to have a description of the variables used in the estimations.

¹¹³I tried to use the distance to the nearest deposit as an instrument too. However, it remained weak in the first stage. This is due several factors. First, the exploitation of mineral deposits really began to surge after the 1840s in France, which reduces its potential influence on the concentration of metallurgic factories in the surrounding municipalities. Secondly, this sector has for a long time been relying on the use of charcoal, not coal itself, and water-powered engines (Woronoff, 1998). The distance between factories and the main mines was also a factor which favoured the use of these alternative resources (Crouzet, 1996). Finally, even if textile and food sectors were more intensively relying on the use of steam engines powered by coal, they were still using far more water-powered engines at that time (around six times more in the food sector for example). Their location was therefore not greatly dependent on the presence of deposits in a given municipality.

Logit, is technically off-limits in this case. There are of course also drawbacks in using least squares to estimate relations on dummies. However, since there was most of the times only one school (in 80% of the cases) and one or two factories per municipality (in 70% of the municipalities with an industry)¹¹⁴, I am forced to stick to estimations on binary indicators.

4.2 Instrument's Validity

As presented in (2), I use the location of coal, iron and copper deposits to instrument the presence of industrial factories. These deposits were present in 237 municipalities. Over these 237 cases, a factory was located in the same municipality in 81 cases, a large factory more than 20 workers in 56 cases. The rationale is that factories could have been present in the same municipalities as they were exploiting directly these deposits (55 cases over 81). Another reason explaining this correspondence would be that mining activities attracted other industrial factories (as clothing, food industry, ...) because, by fixing the labour-force, they were creating additional outlets for these other sectors. Then, these activities may have continued to exist, even if the deposit was depleted and mining factories closed. It is also possible to imagine that some industries were randomly present in municipalities where deposits were located. This could be true in the case of non-exploited deposits. The main issue with the instrument used is the reduction in the source of the identifying variation. Indeed, the number of observations on industry falls greatly by using this technique. However, this should lead to the identification of a clear causal effect and prevent the analysis from being biased because of reverse causality and omitted variables. Therefore, the impact of industry should be robustly identified using this technique.

Indeed, it is hard to imagine why municipalities with ore would be richer than their counterparts, for another reason than the exploitation of the deposit by a manufacture and the potential attraction of other industrial sectors. Municipalities with deposits were as likely as the others to be located close to commercial networks for example or in districts with high agricultural resources. In the data, the average agricultural land value between districts was not varying significantly with the presence of deposits. More generally, these municipalities were unlikely to be correlated with a third factor that would have driven both schools and factories' presence. Finally, even if this point is less problematic, a potential reverse causality bias would also be avoided by this instrumental variable strategy.

Unfortunately, it is hard to test if the presence of a deposit was correlated with a third factor at the municipal level. The same is true for pre-industrial human capital accumulation and economic development. Therefore, I can only rely on data at the department level. In Table 2.2, following (Franck and Galor, 2017), I regress the literacy rate in 1686-1690 (taken as the percentage of spouses who could sign their marriage license) and urban population in 1700 (the total population by department in towns more than 10 000 inhabitants), taken as a proxy

¹¹⁴There were less than seven factories per municipality in 90% of the municipalities with industrial activities. This makes the use of the number of factories difficult and increases the probability to find an effect driven by outliers or only by a small number of big towns.

for development, on the number of deposits per department. This is done in order to check if deposits' presence was correlated with pre-industrial development indicators. Indeed, the presence of factories and human capital accumulation may have been driven by these pre-industrial characteristics. The number of deposits was not significantly linked with literacy rates, either considering only men, women, or spouses. This was also true for urban population in 1700. The influence of industrial activities instrumented by the presence of ore is therefore unlikely to be driven by a pre-industrial higher capital accumulation or economic development. The reinforces the reliability of the instrument used.

In the same table, I also report the correlations between the presence of ore and several development indicators of the early nineteenth century. This provides an evaluation of the potential link between mineral deposits and a third factor which could have influenced both factories' and primary schools' presence. There was no significant association between deposits, life expectancy or mortality between 0 and 5 years in 1806-1810. The same if true for the percentage of twenty years old conscripts, born between 1798 and 1810, whose height was above the average national height of conscripts¹¹⁵. This last measure can be taken as a fairly good approximation of economic development in France at that time (Villermé, 1829), (Komlos et al., 2003)¹¹⁶. Therefore, the number of deposits within departments was not significantly correlated with pre-industrial human capital, development or with the level of economic resources in the early nineteenth century.

Table 2.2: Deposits, pre-industrial development and department characteristics. OLS and Tobit estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Literacy - spouses 1686-1690	Literacy - men 1686-1690	Literacy - women 1686-1690	Urban population 1700	High heights of conscripts	Life expectancy 1806-1810	Mortality rate 0-5 years 1806-1810
Deposits	-0.106 (-0.863)	-0.114 (-0.681)	-0.093 (-1.102)	-0.554 (-1.267)	-0.030 (-0.417)	0.067 (1.041)	-0.001 (-1.076)
Altitude	0.004 (0.904)	0.006 (0.962)	0.002 (0.682)	-0.065*** (-2.817)	0.002 (0.806)	-0.003 (-1.154)	0.000 (1.189)
Surface area	-0.006*** (-3.325)	-0.008*** (-3.292)	-0.003*** (-2.851)	-0.003 (-0.429)	-0.007*** (-6.656)	-0.004*** (-4.198)	0.000*** (4.343)
Observations	75	75	75	84	83	84	84
Left-censored observations				39			
Uncensored observations				45			
R^2	0.139	0.134	0.112		0.373	0.252	0.265
Pseudo- R^2				0.026			

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: *Statistique générale de la France*. IGN and BRGM data. Data on the height of conscripts is coming from (Aron et al., 1972), on life expectancy and morality rate from (Bonneuil, 1997). Urban population in 1700 is provided by (Lepetit, 1988).

Notes: *Deposits* refers to the number of deposit in each department. Surface area is measured in hectares, the average altitude in meters. They correspond to the average surface area and altitude of municipalities within each department. Literacy rates are defined as the percentage of men, women or spouses who could sign their marriage license. *High heights* refers to the percentage of 20 years old conscripts born between 1798 and 1810 whose height was above the national average height of all conscripts.

There is also no strong reason to believe that deposits influenced directly the presence of schools and that the exclusion restriction would not hold, as specified before. These schools were not

¹¹⁵These data, analysed in (Aron et al., 1972), rely on the evaluation of 489 610 conscripts' height.

¹¹⁶See (Steckel, 1995) for a review of the literature on this point.

relying on deposits for their functioning. Moreover, there is no major geographical differences between municipalities with deposits and their counterparts. The former were located at an average altitude of 250 meters against 206 for the latter, a contrast unlikely to have influenced greatly the presence of primary schools.

5 A Positive Influence of Industrial Activities on Primary Schools' Presence

5.1 OLS Estimations

In Table 2.3, I regress the presence of primary schools on economic, demographic and geographic variables without using any instrument. Among demographical factors, population dispersion and total population's impacts remain significant with district fixed effects (columns 1 to 3), no fixed effects and district controls (columns 4 to 6), and department fixed effects (columns 7 to 9). A standard deviation in population dispersion was implying a fall of around 6 percentage points in the probability of primary schools' presence, a standard deviation in total population in 1793 an increase of around 30 percentage points¹¹⁷. Altitude was detrimental to the presence of schools while the width of municipalities had a positive impact on their presence.

The effect of industrial variables is positive and significant when district controls are introduced without department fixed effects¹¹⁸. The presence of at least one factory was increasing the probability to have at least one primary school in the same municipality by 9.5 percentage points. A one unit increase in the total number of factories was leading to a 2.1 percentage point increase of the same probability. Finally, the presence of a factory with more than 20 workers (the 37% biggest ones) was increasing this probability by 8.2 percentage points. Industrial activities were therefore linked to a higher spreading of primary schools. This effect was greatly due to the presence of large factories and was reinforced when several manufactures were located in the same municipality¹¹⁹. The association between schools and industry becomes non-significant when district or department fixed effects are introduced. Only the total number of factories remains significant at a ten or five-percent level, with a magnitude or around 1 percentage point. Therefore, the intensity of industrial factories' presence was more closely associated with primary schools¹²⁰.

¹¹⁷This is in line with descriptive statistics showing that schools were located in municipalities with a higher population, in 1793 and 1833, and a lower population dispersion. See Table 2.A4 in the Appendix.

¹¹⁸Descriptively, there is a strong association between schools and factories since, in 79% of the municipalities with a factory, a school was also present. See Table 2.A5 in the Appendix.

¹¹⁹Ideally, one would like to decompose the effect of manufactures on primary schooling by taking other thresholds on the number of workers. However, this would often amount to restricting data too much for any econometric analysis. This is also why I stick to factories more than 20 workers to measure the impact of large manufactures on primary instruction.

¹²⁰Logit estimations lead to similar results. Odds-ratio indicate that the presence of a primary school in a given municipality was around 1.7 times more likely when a (large) factory was located in the same area. The increase was of respectively 1.2 for any additional factory. However, the outcomes are only significant when agricultural controls are introduced without department fixed effects, except for the number of factories. See Table 2.A6 in the Appendix.

Table 2.3: Industrial (large) factories and primary schools. OLS estimations

	Dependent variable: Primary School								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	0.017 (0.820)	–	–	0.095*** (3.535)	–	–	0.010 (0.476)	–	–
Number of factories	–	0.008* (1.923)	–	–	0.021*** (4.252)	–	–	0.007 (1.556)	–
Factories > 20 workers	–	–	0.021 (0.895)	–	–	0.082*** (2.794)	–	–	0.008 (0.340)
Population dispersion	-0.047*** (-5.104)	-0.046*** (-5.118)	-0.047*** (-5.097)	-0.072*** (-3.008)	-0.072*** (-2.990)	-0.072*** (-3.013)	-0.059*** (-4.574)	-0.059*** (-4.568)	-0.059*** (-4.572)
Population - 1793	0.287*** (7.165)	0.285*** (7.163)	0.287*** (7.300)	0.260*** (5.467)	0.263*** (5.474)	0.266*** (5.594)	0.296*** (6.823)	0.294*** (6.807)	0.297*** (6.966)
Altitude	-0.049* (-1.670)	-0.050* (-1.675)	-0.050* (-1.683)	-0.025 (-1.269)	-0.025 (-1.285)	-0.026 (-1.342)	-0.052** (-2.068)	-0.052** (-2.074)	-0.053** (-2.086)
Surface area	0.031** (2.387)	0.031** (2.422)	0.031** (2.419)	0.007 (0.408)	0.009 (0.485)	0.008 (0.474)	0.030* (1.895)	0.031* (1.911)	0.030* (1.908)
Agricultural controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	No	No	No	No	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	No	No	No	No	No	No
Number of clusters	91	91	91	88	88	88	88	88	88
Observations	6626	6626	6626	6621	6621	6621	6621	6621	6621
R^2	0.456	0.456	0.456	0.209	0.208	0.207	0.354	0.354	0.354

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: *Primary school* is an indicator variable which takes value 1 if at least a primary school was located in the municipality at stake. *Industry* and *Factories > 20 workers* are also dummy variables taking value 1 if a manufacture (more than 20 workers) was present in the given municipality. Population, population dispersion, surface area and average altitude are standardised. Surface area is measured in hectares, the average altitude in meters.

5.2 A Stronger Effect with IV Estimations

In Table 2.4, I regress the presence of primary schools on industrial characteristics using the instrumental variable strategy presented. In all specifications, the presence of ore is significantly linked to factories in the first stage. The Sanderson-Windmeijer *F-stat* is superior to ten in the two last cases, which tends to exclude the issue of weak instrument. This also prevents the estimations to be greatly biased if the presence of deposits was even slightly directly correlated with the location of primary schools (Bound et al., 1995). The *Regression based p-value*¹²¹ is inferior or close to 10% which means that I can reject the exogeneity hypothesis of the *Industry* variable. IV estimations are therefore recommended.

The influence of the presence of industrial factories is always positive and significant at a ten-percent level, with a magnitude between 37 and 42 percentage points, which is much higher than the effect estimated by OLS. As 56.95% of the municipalities without industry had a primary school, if industrial factories were to be present in each of these municipalities, primary schools

¹²¹It relies on a test robust to clustering developed by Wooldridge.

would be located in almost every one of them too. When interpreting the effect of factories' presence, it is interesting to look at its magnitude on the stock of primary schools. As they were located in 11.48% of the municipalities, the effect of manufactures on the stock of schools was of around (11.48×37) 4 percentage points. Therefore, over the 59.5% of municipalities in which at least one primary school was present, 4 percentage points of them could be explained by the presence of factories. This amounts to around 370 municipalities over the 4 836 in which a school was present.

Table 2.4: IV estimation - Industrial factories and primary schools.

	Dependent variable: Primary School		
	(1)	(2)	(3)
Industry	0.425*	0.427*	0.371*
	(1.901)	(1.952)	(1.850)
Agricultural controls	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes
Department fixed effects	No	No	Yes
District fixed effects	Yes	No	No
Number of clusters	91	88	88
First-stage, dependent variable is the presence of industrial activities			
Presence of ore	0.144***	0.162***	0.160***
	(4.20)	(4.76)	(4.65)
Observations	6626	6621	6621
R^2	0.155	0.047	0.101
$F - stat$	7.925	14.024	10.321
Regression-based p-value	0.060	0.131	0.079

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the location of primary schools in a given municipality.

In order to specify this effect, I look at the influence of mining activities on schools. Indeed, as the instrument used is the presence of deposits, it is strongly correlated with the location of these activities. In Table 2.5, I use the same specification to measure this relation. A significant and positive effect is found, the presence of a mine increasing by around 33 percentage points the probability for a primary school to be found in the same municipality¹²². The effect of industrial activities found with the IV strategy was therefore greatly due to the mining sector,

¹²²The stock interpretation is less interesting here as mining activities were present in only 1.21% of municipalities.

which is logical given the nature of the instrument used.

Moreover, this table helps to understand the high magnitude of the IV coefficients. Indeed, 11.5 factories were on average present in municipalities with mining activities against 3.6 in those with industrial activities but belonging to other sectors¹²³. This is in line with the positive and robust effect of the total number of factories on primary schools identified in the OLS estimations. The presence of mines in these estimations is synonymous to the presence of several factories, the number of which was shown to be positively correlated to primary schools. Therefore, instrumenting the presence of factories is actually equivalent to instrumenting the presence of an average high number of manufactures. This accounts for the stronger effect found with IV estimations. Unfortunately, since the instrument used restrict highly the number of observations, I cannot include the total number of factories in the regressions. In around 70% of the municipalities with industrial activities and a deposit, only one or two factories were present. As a consequence, the first stage becomes invalid when instrumenting the number of manufacturers by the presence of deposits.

In the same table, I also report estimation coefficients of the relation between the presence of large factories with more than 20 workers, and the location of primary schools. Descriptively, there is a positive association between the two since 81.6% of the municipalities with a big-size factory were characterised by the presence of a primary school. Even if the effect is not significant in the second specification, the presence of these factories was entailing an increase of around 43 percentage points of the primary schools' presence probability. This higher effect is coherent with what was expected since large factories were more likely to attract, be attracted by and to develop along with other activities. Indeed 319 industrial workers were on average employed in municipalities with factories more than 20 workers, with a median value of 104 workers. The income effect potentially induced by industrial production was likely to be higher when manufacturers were employing more people. Indeed, a higher production was associated with a greater amount of taxes collected by municipalities.

¹²³The difference between the two being significant at a one-percent level. This is coherent with what was found in other studies on the effect of mining activities, and especially coal, on the development of cities (Fernihough and O'Rourke, 2014).

Table 2.5: IV estimation - Mining activities, large factories and primary schools.

	Dependent variable: Primary School					
	(1)	(2)	(3)	(4)	(5)	(6)
Mining activities	0.347** (2.076)	0.383* (1.943)	0.330* (1.937)	–	–	–
Factories > 20 workers	–	–	–	0.498* (1.819)	0.481* (1.673)	0.434* (1.712)
Agricultural controls	No	Yes	Yes	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	Yes	No	No	Yes
District fixed effects	Yes	No	No	Yes	No	No
Number of clusters	91	88	88	91	88	88
First-stage, dependent variable is:	Mining activities			Large factories		
Presence of ore	0.177*** (5.97)	0.181*** (6.01)	0.180*** (6.02)	0.123*** (4.15)	0.144*** (4.82)	0.136*** (4.53)
Observations	6626	6621	6621	6626	6621	6621
R^2	0.136	0.102	0.110	0.106	0.035	0.061
$F - stat$	14.737	16.030	15.892	9.683	13.113	11.473
Regression-based p-value	0.227	0.151	0.157	0.058	0.114	0.073

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the location of primary schools in a given municipality.

In all these estimations, one may fear that a few number of municipalities with highly developed industrial activities and a primary school would drive the results. As a robustness check, and in order to exclude potential outliers from the estimations when using the deposit instrument, I restricted the sample in terms of industrial production value, of number of factories and population. I looked at the value of these variables in municipalities with both a deposit and a factory. Then, I dropped the upper 10% for each of these three variables and ran the same estimations than in Table 2.4. As a consequence, they are computed on municipalities with no more than six factories, or with an industrial production value less or equal to 1 492 608 francs per year or, finally, with a population less than 4 875 inhabitants. The impact of industry on the presence of primary schools remains significant in all these specifications, with a magnitude that is not decreased by the restrictions applied. This reinforces the idea that the impact of industrial activities on primary schooling was not driven by any outlier in terms of industrial presence¹²⁴.

I also changed the measure of population in the estimations and took the figures coming from

¹²⁴See Table 2.A7 in the Appendix.

the Guizot survey in 1833 instead of population in 1793. The level of significance was not affected by this modification but the magnitude of industrial coefficients was slightly decreased by it. This is coherent with the fact that population in 1833 may be a bad control and might have been influenced by the previous implementation of industrial activities¹²⁵.

The effect of factories' presence on the location of primary schools is also robust to the control for spatial autocorrelation in the error term. I computed Conley standard errors (Conley, 1999) based on four different radii of 25, 50, 75 and 100 kilometres following the methodology used in (Ashraf and Galor, 2011). GMM estimations deliver results close to the ones found so far and the impact of industrial activities remains significant¹²⁶. Finally, I run the same estimations as in Table 2.4 but excluding municipalities with textile factories. Indeed, education has been shown to have positively influenced non-textile industry in nineteenth-century Prussia, while the association with the textile sector remained non-significant. As this sector was relying more on child work, one could expect a higher effect of industry on education when excluding it from the analysis. The outcomes remain significant, with a slightly lower magnitude¹²⁷. This is due to the fact that textile was a leading sector at that time, whose production was high and could enhance primary schooling through an income effect. Its influence on enrolment is more deeply discussed in Section 7.

So far, I have shown that industrial activities were influencing positively the presence and maintaining of primary schools. The influence of geographic and demographic characteristics of municipalities was also far from being negligible. Several transmission channels can be thought of in order to explain this relation : higher expected returns from families¹²⁸ and local authorities, direct investment of businessmen into schooling, a higher demand for an educated workforce where activities were dynamic, an income effect through taxes collected on the industrial production, ...

Among them, the last one seems to be the most relevant historically. Indeed, if a high demand for skills in economic activities entailing both a greater investment of businessmen into schooling and higher education returns for families existed historically, it seems that it characterised rather the second phase of the industrialisation process¹²⁹. The first phase, at the beginning of the nineteenth century, was linked to an accumulation of physical capital, with a low complementarity with human capital (Mitch, 1993). The increase of this complementarity in the second phase, beginning rather in the 1860s-70s in the case of France, is considered as explaining the rise in industrial wages along with the fall in rental value and inequalities (Allen, 2009), (Galor and Moav, 2006). Therefore, it seems unlikely that primary schools developed along with industrial activities following the logic of the demand for skills. This point will be more deeply analysed in Section 7 of this paper.

¹²⁵See Table 2.A8 in the Appendix.

¹²⁶See Table 2.A9 and Table 2.A10 in the Appendix.

¹²⁷See Table 2.A11 in the Appendix.

¹²⁸Even if the evaluation of these returns by families is far from obvious (Jensen, 2010).

¹²⁹The greater investment of businessmen into the schooling system was also due to the will to bypass factory laws aiming at regulating child work. This was especially the case in France after the passing of the 1841 law, the first one defining an upper bound on day-work hours for children depending on their age.

6 A Supply-Side Effect Trough the Economic Resources of Municipalities

From a descriptive point a view, municipalities with factories were more often paying teachers on a regular basis (53% of them against 37% when no industry was present), providing them more often with an accommodation (40% against 27%) and a classroom (45% against 37%)¹³⁰. Moreover, on average, municipalities with a school but no industry were providing teachers with a low annual fixed salary of 147 francs, compared to the minimum level of 200 francs subsequently implemented by the Guizot Law. This level was on the contrary already attained and surpassed in towns with schools and factories, with an average salary amount of 262 francs. Therefore, the provision of public schools was positively correlated to the industrial presence.

In order to investigate the causality of this effect, I regress in Table 2.6 the probability for a teacher to have a fixed salary, which was the most common form of public grant provided in 39% of the municipalities, on the presence of industrial factories more than 20 workers. This subsidy was the sign of a strong municipal involvement in primary instruction since, contrary to the other grants, it implied an annual contract and provision of funds from the municipality to the teacher. Consequently, a fixed salary was increasing greatly the stability of teachers' presence in a given town. This grant was therefore the most robust indicator of a strong and stable public supply of primary schools. I keep all the observations here and not only the cases of municipalities with a school. Therefore, I capture two effects at the same time. First, compared to municipalities with no schools, the influence of industrial activities on the opening of a school with a teacher paid on a regular basis. Second, compared to municipalities with schools but no regular salary, the influence of these activities on the probability to pay teachers regularly. I am forced to do so since the instrument becomes too weak when focusing only on municipalities with schools.

¹³⁰See Table 2.A12 in the Appendix.

Table 2.6: IV estimation - Large factories and fixed salary provision.

	Dependent variable: Fixed salary					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Factories > 20 workers	0.061*** (2.641)	0.105*** (2.863)	0.059** (2.393)	0.472** (1.969)	0.540* (1.938)	0.448* (1.945)
Agricultural controls	No	Yes	Yes	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	Yes	No	No	Yes
District fixed effects	Yes	No	No	Yes	No	No
Number of clusters	91	88	88	91	88	88
First-stage, dependent variable is:	Large factories					
Presence of ore				0.123*** (4.15)	0.144*** (4.82)	0.136*** (4.53)
Observations	6626	6621	6621	6626	6621	6621
R^2	0.427	0.214	0.356	0.403	0.185	0.333
$F - stat$				9.683	13.113	11.473
Regression-based p-value				0.079	0.108	0.084

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the presence of a teacher paid on a regular annual basis in a given municipality.

The effects are in compliance with what was found previously. The impact of large industrial factories presence is of around 45 percentage points. As teachers paid on a regular basis were present in 37.8% of the municipalities without large manufactures, the generalisation of industrial production would have theoretically entailed a globally shared financial capacity to pay teachers. In stock terms, as paid teachers were present in 38.92% of the municipalities, (45*11.48) 5.2 percentage points of them can be explained by the presence of factories. The effect estimated with OLS is positive and significant but with a much lower magnitude (around 6.5%), as expected¹³¹. The effect of the mere presence of factories was also significant in this case. I only report the influence of large factories since it was driving most of the impact on public investment in primary schooling¹³². The influence of (large) factories' presence is also

¹³¹Logit estimations also lead to the identification of a positive and significant association between the presence of large factories and the probability for a teacher to be paid. The coefficients are significant at a five or one-percent level. Odds-ratios indicate that teachers were around 1.5 times more likely to be paid regularly when a large factory was located in the same municipality. Results are available upon request.

¹³²See Table 2.A13 in the Appendix.

robust to the control for spatial autocorrelation in the error term¹³³. Large factories were more closely linked to public education than to the mere presence of schools, especially to private ones financed only through fees. Therefore, the positive effect of industrial activities on primary schools was due to an increase in the supply of public schools. In municipalities with factories, local authorities more often invested in education by paying teachers on a regular basis. This positive influence on schooling supply went through an income effect on municipal resources¹³⁴. Indeed, if these municipalities were more capable to invest in instruction, it is because industrial activities were directly contributing to municipal resources through the taxes collected on their production, the *patente*¹³⁵. The basis of this tax was incomes coming from trade and industry. However, it is only by means of rental value that these resources were taxed. The *patente* amounted to a percentage between 10 and 15% of the rental value of industrial buildings. An additional component depended directly on the number of workers and engines used in the production process (Chanut et al., 2000). Therefore, municipalities collecting more taxes on industrial activities were also more likely to invest greatly in primary schooling. Descriptively, this was indeed the case as both production value and taxes on this production were higher in towns with schools, where a fixed salary or an accommodation were provided to teachers¹³⁶. For example, these taxes amounted on average to 123 francs per year in municipalities paying teachers regularly against 60 francs in those which didn't. The figures for what regards accommodation were respectively 167 and 51 francs. Therefore, the municipalities investing more in education were also those whose economic resources coming from industrial activities were the highest.

The use of OLS estimations in Table 2.7 shows that taxes on industrial activities were linked to a higher investment in primary schooling. Indeed, municipalities with schools were more likely to pay teachers on a regular basis and to pay them more if industrial taxes collected were high. One standard deviation increase in the amount of taxes collected was increasing the probability to pay teachers regularly by 7 percentage points, while it increased their salary by an amount between 28 and 37 francs. This positive effect of taxes explains also why the presence of large factories was influencing highly primary schooling. Indeed, production value and taxes collected on manufactures were about ten times higher in municipalities with large factories than in municipalities with factories less than 20 workers¹³⁷.

Since the industrial production value may have varied during the years separating its measure from the one of teachers' salary, I restricted the analysis to municipalities with large factories as a robustness check. As said before, their presence is more likely to have been long lasting than for smaller manufactures. The association between taxes on the industrial production and

¹³³See Table 2.A14 and Table 2.A15 in the Appendix.

¹³⁴One may consider municipal investment as a potential residue to parents' willingness to pay for education. However, municipalities invested more in instruction in richer areas where enrolment rates were on average higher (Montalbo, 2019). As a consequence, industry is not likely to have influenced the public supply of education because parents were less willing to school their children in the municipalities at stake.

¹³⁵One of the four direct taxes, the *quatre vieilles*, implemented by the Assemblée Constituante in 1791, along with the land tax, the personal property tax and the tax on doors and windows (implemented in 1798).

¹³⁶See Table 2.A16 in the Appendix.

¹³⁷See Table 2.A17 in the Appendix.

teachers' salary remained significant¹³⁸. However, I find no significant effect of taxes on primary schooling using the same instrumental variable strategy used previously. The *F-stat* remains too low in the first stage, which makes the estimations unreliable. This is firstly due to the limited identifying variation kept when using the mineral deposit instrument and restricting at the same time the sample only to municipalities with primary schools. However, keeping all observations for the impact on a fixed salary provision wouldn't make the first stage reliable. Indeed, factories located in municipalities without deposits could also produce substantially, which makes the instrument less likely to strongly predict the level of industrial production and taxes. Descriptive statistics and correlations computed with OLS estimations are however still useful. The presence of (large) factories did cause an increase in the provision of public schools. It is therefore reassuring and instructive to know that the municipalities at stake were indeed those benefiting from higher amounts of taxes based on the volume of industrial production.

Table 2.7: Industrial activities and human capital accumulation.

	Fixed salary				Salary amount			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Taxes on industrial activities	0.067 (1.651)	0.067** (2.397)	0.382 (1.100)	0.342 (1.257)	37.536** (2.217)	28.438** (2.290)	-50.814 (-0.578)	-23.710 (-0.262)
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
District fixed effects	No	No	No	No	No	No	No	No
Number of clusters	80	80	80	80	80	80	80	80
First-stage, dependent variable is:			Large factories				Large factories	
Presence of ore			0.135*** (3.63)	0.132*** (3.54)			0.139*** (3.56)	0.136*** (3.49)
Observations	3881	3881	3881	3881	3881	3881	3881	3881
R^2	0.149	0.270	0.129	0.255	0.205	0.359	0.190	0.354
$F - stat$			4.602	4.766			4.602	4.766
Regression-based p-value			0.318	0.269			0.309	0.568

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, postal and Guizot surveys. IGN and BRGM data.

Notes: Only municipalities with schools are taken into account. Taxes on industrial activities are standardised.

¹³⁸See Table 2.A18 in the Appendix.

7 Industrial Activities, Demand for Schooling and Human Capital

Industrial activities influenced positively the number of schools through a positive income effect on public supply. However, this is not equivalent to a positive impact on primary schooling. Indeed, many industrial sectors relied heavily on child work. This might have entailed a negative effect of industry on the demand for schooling and human capital accumulation. In the British case for example, the study of household accounts and of a large body of biographies revealed an upsurge in child labour¹³⁹ within industrial sectors during the first part of the nineteenth century (Humphries, 2012), (Humphries, 2010)¹⁴⁰. The same kind of phenomenon was identified in the American cotton and wool industries between 1820 and 1850 (Goldin and Sokoloff, 1982). In the case of French textile industry¹⁴¹, the high reliance on child work was described as linked to the development of mechanisation and a more acute division of labour, contributing to make children more productive and their work complementary to the one of adults. The impoverishment of families was also associated with this phenomenon, especially in cotton industry, as social observers of that time already noted (Villermé, 1971, 1840) (Heywood, 1988)¹⁴².

In this section, I investigate the relation between industry and the demand for schooling by focusing on enrolment rates, on the number of subject taught within schools and on schooling years. I show that, if industry contributed positively to the supply of schools, it was negatively associated to enrolment rates and therefore to the extensive margin of human capital accumulation. The relation with its intensive margin (Were children in schools learning more when an industry was located in the same municipality ?) appears to have been only slightly positive. The influence of industrial production on primary schooling is therefore very unlikely to have been due to a higher demand for skills within industrial sectors. As specified before, the restriction to municipalities with schools makes the instrument too weak to be reliable when focusing on the mere presence of industrial activities. In this section, I also have to separate the estimations depending on the level of population to compute enrolment rates. This reduces even more the number of industrial observations that the instrument can catch. This is why I add estimations on the effect of the mining sector in this section, for which the instrument is the strongest. In spite of the restrictions applied, this latter remains strong enough to interpret

¹³⁹This rise went hand in hand with a fall in the age at which children were starting to work.

¹⁴⁰The employment of children during the Industrial Revolution has been questioned in the English case. The reliability of quantitative data and assumptions made about the work of farmers' children were central in this debate. On this point, see (Cunningham, 1990) and the replies (Kirby, 2005), (Cunningham, 2005).

¹⁴¹Around 145 000 children under 16 years old were working in the industry according to the industrial survey, two-third of them in textile manufactures.

¹⁴²Cotton industry was rapidly expanding at the beginning of the nineteenth century in France, especially in the Haut-Rhin department, in towns like Mulhouse or villages like Thann and Dornach and, for the department of Seine-Inférieure (named Seine-Maritime nowadays), in towns like Elbeuf. The negative effect of industrial activities on child work also seems to have been reinforced by the poor enforcement of factory laws in the time period following the one under scrutiny in this study. See for example (Saito, 2006), (Weissbach, 1977), (Pierrard, 1974) and (Pierrard, 1987) in the case of the 1841 law regulating child work in French manufactures.

the relations as causal for this sector. For the general case, this part of the analysis will remain descriptive as I can't rely on the IV estimations.

7.1 A Negative Association with Enrolment Rates

Since I do not know the age structure within municipalities, enrolment is measured as the number of pupils per 100 inhabitants. The population used to do so is the one reported in the Guizot survey or from the *Statistique générale de la France* in 1836 if it is missing in the survey. To reduce the bias potentially linked to this approximation, I divide municipalities in groups depending on their population size, making the assumption that the age structure was likely to be close in each category. A first simple division consists in separating municipalities less than 2 000 inhabitants (around 90% of the municipalities in the sample) from the ones above this threshold. As there are only 5% of the municipalities in the second category with more than 8 000 inhabitants, each group should be quite homogeneous. Descriptively, the presence of (large) factories was related negatively to enrolment rates in small towns¹⁴³. Around 10.5 pupils were schooled during winter months in municipalities less than 2 000 inhabitants with no factories, against 8 in their counterparts. In municipalities above the threshold, these figures were respectively of 3.6 and 4.7¹⁴⁴. Therefore, for the vast majority of towns and villages, the presence of industrial activities was associated with lower enrolment rates.

In Table 2.8, I regress the number of pupils per 100 inhabitants attending schools in winter on the presence of factories and mining activities¹⁴⁵. I report directly the coefficients estimated with the introduction of department fixed effects. To reduce biases linked to age structure and migration flows, I divide estimations by population bounds, estimating the effects on municipalities less than 2 000 inhabitants and on those more than 631, which is the median population level. I don't report the coefficients on municipalities below this level as the effect is close to the one on those less than 2 000 inhabitants. This reinforces the idea that municipalities below this threshold were quite homogeneous. The effect found is negative, reducing the number of pupils per 100 inhabitants by around 0.9 for the towns below 2 000 inhabitants. This corresponds to an average reduction of 10% in enrolment rate. Taking the presence of large factories or the industrial production as explanatory factors wouldn't change the results. The effect on the municipalities above median population is on the contrary non-significant.

A greater reliance on child work in smaller villages where families had on average lower economic resources might explain this association. An alternative explanation would be that the presence of more dynamic industrial activities prompted children to enter the workforce simply because they were (perceived as) linked to better career perspectives than primary schooling. Even if there was no legal lower bound on the age of child workers before 1841, these assumptions were

¹⁴³See Table 2.A19 in the Appendix.

¹⁴⁴These differences are significant at a one-percent level for both t-tests depending on the presence of factories or large factories. The variation in enrolment rate levels between big and small municipalities can be explained by the age structure of the population and by the migration of young workers towards bigger towns.

¹⁴⁵Taking winter enrolment makes more sense than taking summer enrolment. Indeed, as many pupils had to assist adults in agricultural tasks, they attended school only between October and April months.

likely to be true for children between 9 or 10 and 15 years old. Indeed, younger children were rarely employed within factories. There was also no clear age bounds on enrolment in primary schools. Primary instruction was typically concerning pupils between 4 and 15 years old, with a potentially high variation in the starting age, in the number of schooling years (5 years on average) and in the regularity of the attendance. Therefore, child work might have affected a significant part of the children who could possibly attend primary schools.

There is no significant association between mining activities and enrolment rates using OLS estimations. This might be explained by the structure of child employment between industrial sectors. Indeed, the mining sector employed relatively few children during the first part of the nineteenth century. 5.2% of its workforce was composed of children less than 16 years old according to the Industrial survey while they represented 10.5% of total industrial workforce¹⁴⁶. Moreover, seven sectors over the sixteen reported in this survey did employ more than 10.5% of children and nine more than 6%. Also, the average number of children employed in manufactures was around 26 in municipalities with industrial activities other than the mining sector and 20 in municipalities with mines. These other sectors may therefore have contributed more than mining activities to the negative association with enrolment rates observed with the use of OLS estimations.

Table 2.8: Industrial factories, mining activities and enrolment.

	Dependent variable: Pupils per 100 inhabitants							
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry	-0.891*** (-2.959)	-0.227 (-0.862)	-4.689 (-1.426)	-2.832 (-1.399)	-	-	-	-
Mining activities	-	-	-	-	-0.425 (-0.925)	0.148 (0.359)	-3.929* (-1.665)	-2.577 (-1.609)
Population	< 2 000	≥ 631 (Median)	< 2 000	≥ 631	< 2 000	≥ 631	< 2 000	≥ 631
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No	No	No	No	No
Number of clusters	79	80	79	80	79	80	79	80
First-stage, dependent variable is:					Industrial activities		Mining activities	
Presence of ore			0.169*** (3.35)	0.172*** (3.37)			0.202*** (4.55)	0.190*** (4.33)
Observations	3526	1916	3526	1916	3526	1916	3526	1916
R^2	0.577	0.658	0.549	0.626	0.575	0.657	0.573	0.653
$F - stat$			5.825	8.373			12.258	12.944
Regression-based p-value			0.087	0.087			0.030	0.039

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: Only municipalities with primary schools are taken into account. The effect of the presence of a manufacture in a given municipality was a reduction in the number of pupils per 100 inhabitants of 0.9 when department fixed effects are introduced.

¹⁴⁶See Table 2.A20 in the Appendix.

Still, using the instrument, I find a negative impact of mining activities on enrolment rates for municipalities less than 2 000 inhabitants, reducing the number of children schooled by around 4 per 100 inhabitants. As specified in section 5, this is due to the fact that the instrument catches the presence of several factories, which is likely to have influenced more strongly and significantly enrolment rates than the presence of only one of them. This is a huge reduction considering the fact that the average enrolment was of around 10.3 children per 100 inhabitants in municipalities less than 2 000 inhabitants. However, descriptively, there was indeed a gap in enrolment between this general case and the municipalities with mining activities where enrolment was on average of 6.9. These estimations therefore exhibit a strong negative impact of the mining sector on enrolment rates and a negative correlation of industry in general with this enrolment. Demand for schooling, in the first part of the nineteenth century in France, was therefore negatively impacted by the presence of mines, and most likely by industry generally speaking.

7.2 More Children in Factories, Lower Enrolment

For the general case, the negative association between industry and enrolment rates was coming from child work (Pierrard, 1987), (Cunningham and Viazzo, 1996). The employment of children was common in the early nineteenth-century France. In the 1820s for example, one-third of the industrial workforce in Alsace was less than 16 years old. Some sectors, as the furniture, textile, luxury, ceramics, building, science and metal objects ones had a workforce composed of more than 10% of children¹⁴⁷. The geographical distribution of textile factories, one of the leading sectors at that time as it accounted for one-third of total industrial product, was closely related to the one of child workers (see Figure 2.2). It was this sector which contributed the most to the employment of children at the national level in absolute terms. Food, chemistry, lightning and leather sectors were, on the contrary, employing a very little share of children (less than 4% of their workforce). Using this data, I split sectors into two groups: a first one in which more than 10% of the workforce was composed of children and a second one in which children were representing less than 10% of total industrial workers. This amounts to selecting the seven sectors employing more children over the sixteen reported in the industrial data.

I estimate their relation with enrolment in Table 2.9. These sectors were associated with a fall in enrolment rates of around 1.4% for the whole sample and 1.5% in municipalities less than 2 000 inhabitants, 2.2% in villages less than median population. This effect was of 0.6% in towns more than this median level. I also find a negative effect of textile and building sectors, which were among the ones employing children more intensively¹⁴⁸. The magnitude of the effect is of around 1.4 children for municipalities less than 2 000 inhabitants and 0.7 for municipalities above median population for the textile sector. The respective figures are of 1.9 and 0.9 for the building sector.

¹⁴⁷See Table 2.A20 in the Appendix to have a decomposition by the 16 sectors reported in the industrial survey. These percentages are computed for France and are not restricted to the 22 departments in my database.

¹⁴⁸Textile factories were located in 308 municipalities in the data, building manufactures in 157.

Manufacturers often resorted to child work because of its complementarity with adults' one, its low cost, the higher docility of children and, sometimes, to avoid innovation (Cunningham, 2000). The Marxist tradition argued that the use of children was meant to decrease the wage of adult workers and ensure higher profits. Descriptively, there was a negative association between child work and the average wage of male adults. In the building and textile sectors, daily industrial male wages were far below the average national level of 1.98 francs, namely 1.78 and 1.82 francs respectively¹⁴⁹. Regressing the presence of sectors using child work intensively (more than 10% of the workforce) and the location of textile factories on daily industrial male wages, I also find that child employment was linked to lower male wages. The effect was negative and significant, with a magnitude of around 14 cents of francs for both¹⁵⁰. Sectors employing more children relative to the total number of workers were therefore also those paying less their male workers in the sample. It is hard to know if the effect followed the Marxist theory or if families more often sent their children to work when wages were low. In any case, the greater reliance on child work was linked to the precariousness of families.

Table 2.9: Child-work intensive industrial sectors and enrolment. OLS estimations

	Dependent variable: Pupils per 100 inhabitants							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sectors > 10% child workers	-1.381*** (-3.789)	-1.458*** (-4.464)	-2.235*** (-5.215)	-0.620** (-2.201)	-	-	-	-
Textile	-	-	-	-	-1.418*** (-3.267)	-0.698* (-1.962)	-	-
Building	-	-	-	-	-	-	-1.854*** (-4.287)	-0.896** (-2.029)
Population	All	< 2 000	≤ 631 (Median)	≥ 631	< 2 000	≥ 631	< 2 000	≥ 631
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No	No	No	No	No
Number of clusters	80	79	66	80	79	80	79	80
Observations	3789	3526	1875	1916	3526	1916	3526	1916
R ²	0.583	0.578	0.432	0.658	0.577	0.658	0.576	0.658

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: In these estimations, all dependent variables are dummies which equal 1 if industrial activities were located in a given municipality. The effect of the sectors in which the average percentage of child workers among industrial workers was superior to ten at the national level is measured, both gathering them into a dummy variable or taking them separately. This corresponded to furniture, textile, luxury, ceramics, building, science-letters and arts and metal objects sectors. The presence of these sectors was related to a fall in enrolment of around 1.4 children per 100 inhabitants when all observations are taken into account.

7.3 Human Capital Accumulation

Industrial activities were therefore associated to lower enrolment rates and had no positive impact on the extensive margin of the demand for schooling. In Table 2.10, I investigate

¹⁴⁹See Table 2.A21 in the Appendix to have the average industrial wages by sector.

¹⁵⁰See Table 2.A22 in the Appendix.

their effect on its intensive margin by regressing industrial variables on the number of subjects taught and the average length of education in primary schools¹⁵¹. The number of subjects was varying between one and eleven. These were: religious instruction, reading, writing, spelling, grammar, arithmetic, land surveying, linear drawing, geography, history and music. The most common subjects were religious instruction, reading and writing which were taught in nearly all the schools¹⁵². The average schooling years were also reported between one and eleven. The education of pupils was typically beginning at five years old and was rarely extended over fifteen years old in the primary institution. Since education was thought in a more linear way than nowadays, one subject being taught after the other, learning more was equivalent to attending school for a longer number of years.

There was a positive and significant association between the presence of large factories and the number of subjects taught¹⁵³. However, no significant relation with the number of schooling years appears in the estimations. It is not possible to know the proportion of pupils that was learning a given number of subjects in each schools thanks to the Guizot survey, but this constitutes an indication that, if indeed more subjects were taught in municipalities with factories, only a very restricted amount of pupils were actually learning all of them. Indeed, if the majority of pupils were so, this should have increase the average schooling length as they were staying at school for a longer period of time. These results indicate that some pupils were learning more, however too few to change the time spent on average by children at school.

In these estimations, the mining sector was not significantly linked either to the number of subjects taught or to the schooling years, whether using the OLS or IV techniques. Therefore, this sector had no impact on the intensive margin of human capital accumulation. This, associated to, at best, a very restricted positive link between large factories and this accumulation reinforces the idea that industry didn't influence human capital in the first part of the nineteenth century in France¹⁵⁴. This is coherent with the work of Diebolt et al., 2017a. They found that industry was influencing positively the supply of primary schools in the first part of the nineteenth century, while, in the second part, its influence on human capital became significant for what regards intermediate skills, proxied by adult education and enrolment in superior primary schools. In its initial phase, and at least until the mid-nineteenth century (Diebolt et al., 2017b), industrialisation (and the food and textile leading sectors) were certainly not enough skill-demanding to influence greatly and significantly the demand either for basic or for intermediary education. This is why I only find a positive but very restricted relation with the accumulation of skills beyond the mere mastering of literacy.

However, it is not possible to know the skill composition of jobs or the number of apprentices

¹⁵¹In 80.4% of the cases, there was only one school in the municipality. When several schools were present, I took the average value of schooling years and number of subjects taught between them.

¹⁵²They were so in respectively 99.4, 98.4 and 92.1% of the primary schools for which this information is available. Arithmetic was taught in 62% of the schools, grammar in 44%, spelling in 49%, geography and linear drawing in 7%, land surveying in 10%, history and music in around 3%.

¹⁵³This is also true for the volume of industrial production.

¹⁵⁴ Moreover, I find no impact in the OLS estimations of the mere presence of factories on the number of subjects. This makes the interpretation of the positive association with large factories and the industrial production as an industry-specific effect even more doubtful.

at the municipality level. Therefore I can't discuss the fact that industrial activities may have had at the same time a negative effect on literacy and enrolment rates but a positive one on the share of skilled workers, as shown by de Pleijt et al., 2018 in the English case, or on the number of apprentices (Feldman and van der Beek, 2015). Even if industry was not skill-demanding for what regards primary education, it may have induced youngsters to become apprentice or workers to learn on the job. Therefore, I can't state that industry didn't induce any accumulation of skills at all in the population. What is on the contrary clearer is that industry had not positive impact on the accumulation of human capital within primary schools. Therefore, primary schooling did not develop along with industrial activities because the skills acquired within schools were useful for industrial tasks. The negative association exhibited between industry and enrolment rates reinforces this idea.

Table 2.10: Industrial activities and human capital accumulation

	Number of subjects		Schooling years		Number of subjects		Schooling years	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Factories > 20 workers	0.311** (2.550)	-1.013 (-0.597)	-0.006 (-0.054)	-1.295 (-1.135)	–	–	–	–
Mining activities	–	–	–	–	0.400 (1.160)	-0.741 (-0.667)	-0.321 (-1.488)	-0.942 (-1.074)
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No	No	No	No	No
Number of clusters	80	80	79	79	80	80	79	79
First-stage, dependent variable is:					Large factories		Mining activities	
Presence of ore	0.132*** (3.54)		0.136*** (3.49)		0.181*** (4.91)		0.187*** (4.86)	
Observations	3880	3880	3725	3725	3880	3880	3725	3725
R^2	0.153	0.125	0.575	0.553	0.152	0.147	0.575	0.574
$F - stat$	6.656		6.961		10.313		11.415	
Regression-based p-value	0.344		0.240		0.218		0.417	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: The presence of factories more than 20 workers is a dummy variable taking value one if a large factory was present in the municipality at stake.

Finally, it is worth noting that I find no strong effect on primary schooling of a potential skill-biased technological change in France during the first part of the industrialisation process. As specified before, the deskilling hypothesis linked to the use of steam engines has been recently re-considered and discussed. Using OLS estimations, I found no significant correlation between the number of steam engines per 100 inhabitant within municipalities and the presence of schools, the public provision of education, enrolment rates, schooling years or the number of

subjects taught¹⁵⁵. Therefore, there is no strong indication that this type of engine had a specific effect on primary schooling. However, there was a high and significant association, higher than with the other types of engines¹⁵⁶, between the use of steam engines, the value of industrial production and industrial taxes collected by the municipalities. Therefore, it is very likely that this new technology acted on primary schooling through a strengthening of the income effect that industry had generally speaking. Indeed, mining activities and large factories which had a positive effect on schools' supply were characterised by the use of a significantly higher number of steam engines¹⁵⁷. As there was no significant correlation between these engines and enrolment, the negative association between this latter and the presence of factories cannot be directly attributed to the use of steam.

I also found a negative correlation between water-powered engines which were more intensively used in large factories, primary schools' presence, enrolment rates and the number of subjects. These engines were clearly the most used at the national level in 1839-1847 with a total of 35 488 of them against 2 473 for the steam ones. Therefore, it seems that industry was negatively associated to enrolment even when it was relying on older types of engines. The introduction of steam power didn't improve or worsen the situation, at least in the first part of the nineteenth century. This may be due to the fact that they were still not representing a sufficiently high share of the total number of engines used. Therefore, there is no strong reason to believe that steam-powered engines influenced either positively or negatively human capital accumulation at that time, or that they impacted the supply of schools through another transmission channel than the income effect exhibited previously.

8 Conclusion

The impact of industrialisation on primary schooling in the early nineteenth-century France may seem to have been odd at first sight. Indeed, the presence of factories contributed to increase the supply of public primary schools through a positive income effect, having at the same time no positive impact on the demand for schooling. There was, on the contrary, a negative association between industry and enrolment rates, due to the prevalence of child work in some sectors like textile. It is even more doubtful to argue that industrial activities caused an increase in the intensive margin of human capital accumulation.

Therefore, one could legitimately wonder why municipalities bothered to invest in education if the demand was the same, while the additional resources coming from industrial production could be used to build or maintain roads for example. In fact, several reasons can be thought of to answer this question. First, local authorities may have wanted to favour the education of the few pupils that were learning from private tutors or, more informally, any altruistic educated adult. Municipalities might also have opened schools thinking that it would be an efficient

¹⁵⁵See Table 2.A23 in the Appendix.

¹⁵⁶These other types were water, wind and animal-traction engines.

¹⁵⁷There was 0.9 of them on average in municipalities with large factories against 0.01 in municipalities with manufactures less than 20 workers and 1.8 in municipalities with mines.

mean to prevent children from working at an early age. The data on enrolment rates tend to indicate that this was in fact not efficient. All along the nineteenth century, industry put a high pressure on primary schooling through the employment of children. Even the laws aiming at regulating child work in factories and pits (in 1841 notably and 1874 to a lesser extent) were easily bypassed by manufacturers, either by conjuring up the negative effects on profits or by creating schools directly within the factories. The laws on compulsory education, the Ferry Laws of 1881-1882 in France, had a stronger effect and dealt a fatal blow to child work. Finally, the imitation of bigger towns may also have played a role in favour of the spread of primary schools.

Therefore, the asymmetrical impact of industrialisation on primary schooling came from the fact that it had an indirect positive income effect on the supply of schools, while it had no or a direct negative effect on enrolment rates and the demand for schooling. This last point deserves a deeper investigation in the French case, especially given the intensive use of children in some industrial sectors. As said before, the absence of effect using the IV strategy is certainly due to the restriction in terms of observations and sectors generated by the use of the mineral deposit instrument. The use of OLS and of IV on the mining sector is at least an indication that industry didn't contribute to increase enrolment rates. Most likely, it contributed to lower enrolment rates by diverting children from schools. Finally, I don't claim in this work that industry never had a positive impact on the demand for skills. However, I find no indication of this phenomenon in the first part of the nineteenth century in France for what regards the skills acquired within primary schools.

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Appendix

Data and descriptive statistics

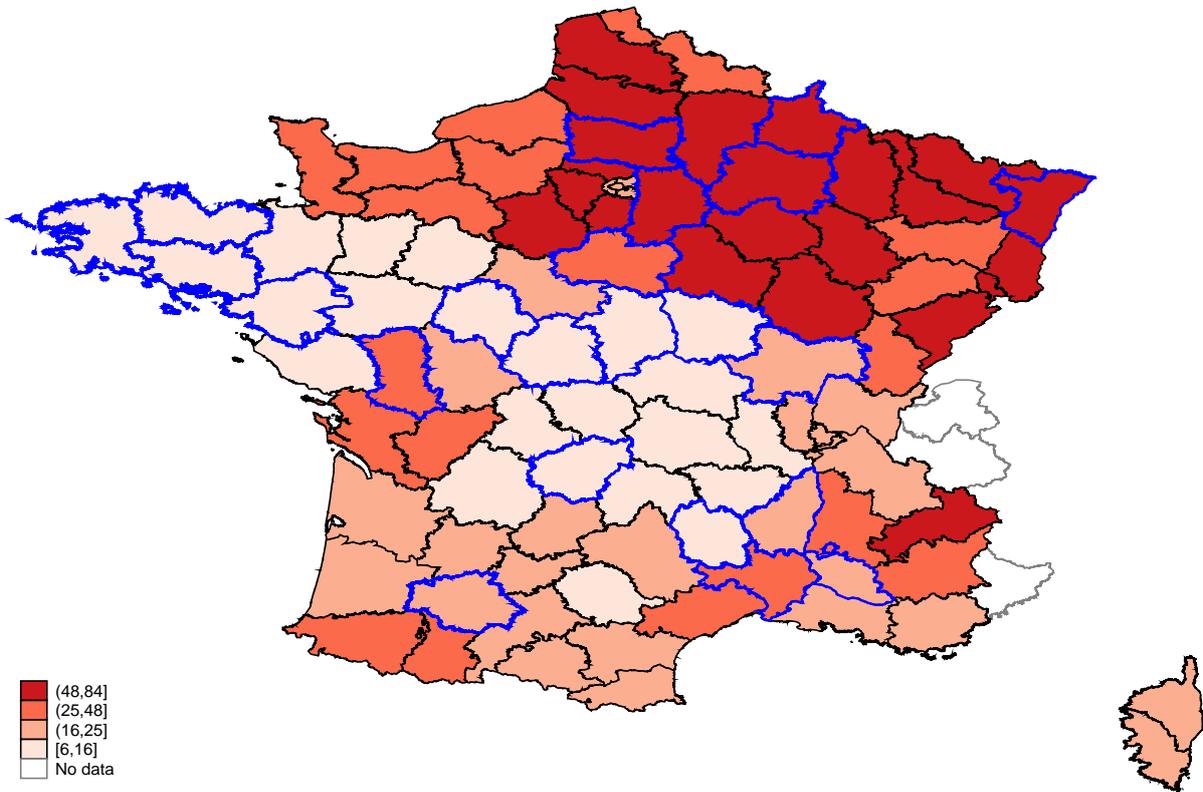


Figure 2.B1: Percentage of children from 5 to 13 years old going to school - winter 1833

Source: Guizot survey - Report to the King, 1851 Census.

Notes: I use here the 1851 Census to take into account the age structure of the population. I consider the proportion of 5 to 13 years old children in the 1851 population and apply it to the 1833 one in order to have the total number of children that could potentially go to school at that time. Therefore, I assume that the major part of the population of children attending primary schools should be contained within these bounds. Then, I compute the percentage of children 5 to 13 years old going to school in 1833 using this measure. Departments in blue are the ones for which education data are available at the level of municipalities.

Table 2.A1: Data representativeness, means and t-tests

	France	Municipal level sample	t-test
Population - 1833	91 948	85 794	NS
Number of municipalities	105	90	***
Percentage of population scattered	49.4	55.4	*
Average altitude - meters	300	211	***
Surface area - hectares	1 566	1 869	***
Percentage of municipalities with schools	71.5	60.8	***
Primary schools per 100 municipalities	215	79	NS
Teachers with a fixed salary per 100 municipalities	48.1	51.9	NS
Teachers with an accommodation per 100 municipalities	43.6	46.8	NS
Pupils per 100 children and single people	19.9	16.5	**
Percentage of municipalities with factories	17.2	21.6	**
Percentage of municipalities with factories > 20 workers	7.6	8.3	NS
Number of industrial workers	3 592	2 531	NS
Industrial male worker daily wage - cents of francs	192	187	NS
Taxes on industrial activities - francs per year	12 733	12 591	NS

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Guizot, industrial and postal surveys. IGN data and *Statistique générale de la France*.

Notes: All figures are computed at the level of districts. The average population in each district was respectively around 85 794 inhabitants for those belonging to the municipality level sample and around 91 948 inhabitants for the entire France. The difference between the two is non-significant.

Table 2.A2: Data representativeness, means and t-tests, municipality and factory levels

	France	Municipal level sample	t-test
Population - 1833	1 526	959	**
Percentage of population scattered	45.7	49.2	***
Average altitude - meters	294	209	***
Surface area - hectares	1 426	1 718	***
Percentage of municipalities with factories	9	10.3	***
Percentage of municipalities with factories > 20 workers	5	5.7	**
Number of industrial workers	89	66	**
Industrial male worker daily wage - cents of francs	198	196	NS
Taxes on industrial activities - francs per year	345	352	NS

*** p<0.01, ** p<0.05, * p<0.1.

Source: Guizot, industrial and postal surveys. IGN data and *Statistique générale de la France*.

Notes: Figures are computed at the level of municipalities for demographic indicators and for the percentage of municipalities with factories. The number of industrial workers, their wages and taxes on the production are computed at the level of factories. For example, the daily wage of industrial male workers was 198 cents of francs over the factories in France, 196 within the sample, the difference between the two being non-significant. The average population per municipality was of 1 526 inhabitants in France, 959 within the sample, the difference between the two being significant at a five-percent level.

Table 2.A3: Summary Statistics - Agricultural controls

Variable	Mean	Std. Dev.	Min.	Max.	N
Day-workers per 100 self-employed	111.6	73.7	19.1	481.2	90
Share-croppers per 100 self-employed	10.7	17.7	0	103	90
Tenant farmers per 100 self-employed	27.7	43.9	0.3	294.8	90
Average land area per self-employed - hectares	17.1	11.6	3.8	74.3	90
Total agricultural area - hectares	150635	46431.5	49732	265577	90
Land value by hectare - francs	1645.9	607.8	625.7	3925.7	90
Food % in day-workers family spendings	66.5	3.9	59.1	79.2	90
Animals per inhabitant	2	1.1	0.4	5	90

Source: Agricultural survey.

Notes: All variables are defined at the districts level. For example the land value by hectare is the average market price of agricultural land between districts.

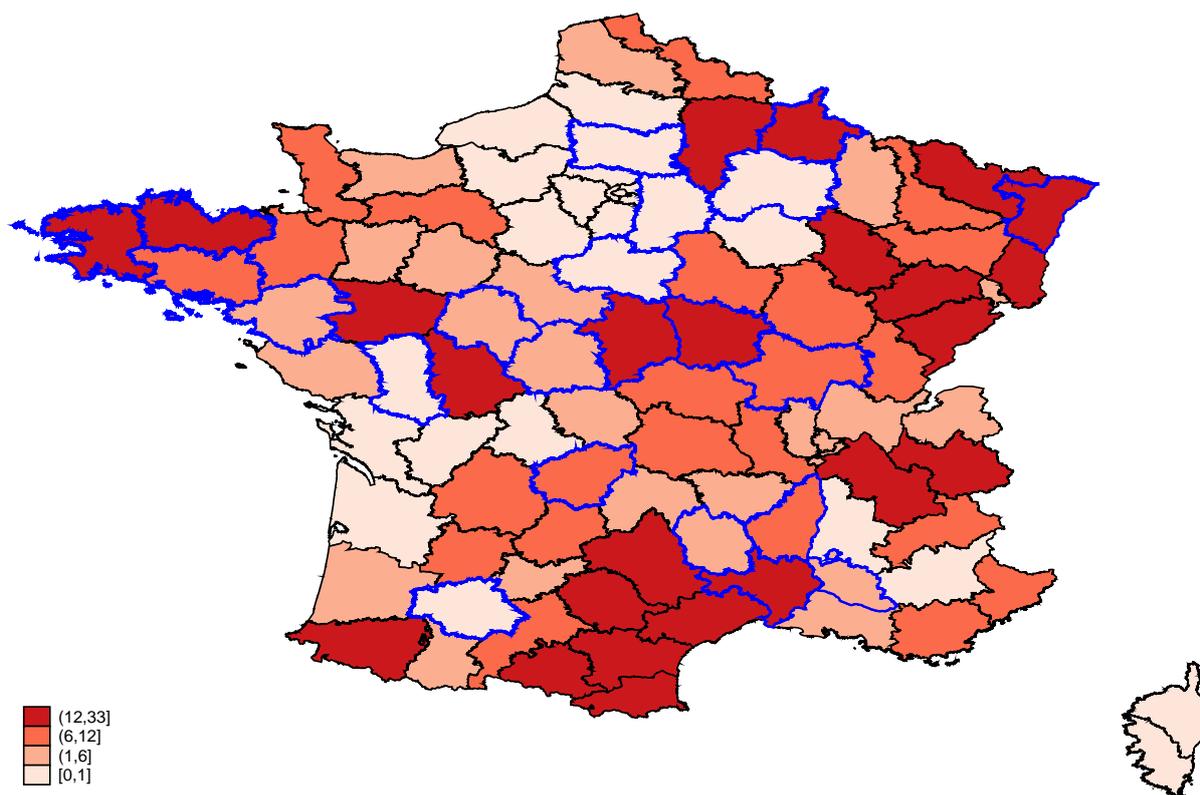


Figure 2.B2: Number of coal, iron or copper deposits

Source: BRGM data.

Description of data

Guizot Survey

School is an indicator variable taking value one if at least one primary school was present in the municipality of reference.

Fixed salary is an indicator variable taking value one if at least one teacher was paid on an annual fixed basis in the municipality at stake. The salary amount was reported in francs per year.

Accommodation is an indicator variable taking value one if at least one teacher was provided with an accommodation or an accommodation allowance by the municipality.

Industrial Survey

Industry is an indicator variable referring to the presence of at least one industrial factory in a given municipality. An industrial factory was reported only if it exceeded ten workers in order not to be mingled with craftsmanship.

Factory > 20 workers is an indicator variable taking value one if at least one industrial factory with more than 20 workers was located in the municipality under scrutiny.

Industrial production value and taxes : they are both defined annually and in francs. Taxes on production were called the *patente* and were based on the rental value of manufactures.

Industrial wages : daily wages of male, female and child industrial workers in cents of francs.

Bureau de Recherches Géologiques et Minières

Location of deposits : copper, iron and coal. Deposits exploited and not-exploited.

Agricultural Survey

In this survey, all the data are available at the district level.

Number of tenant farmers and share-croppers : both were employed by a landowner to work on his fields and were paying him in return. The difference is that share-croppers' payment was in kind (a part of harvests) while tenant farmers paid landowners directly in cash.

Number of day-workers : following (Démonet, 1990), taken as the sum of "aides agricoles" (agricultural assistant) in the survey. They amounted to 3.7 millions over all French territory.

Number of self-employed : are gathered in this category all the agricultural workers that could live from their work in the fields, that is to say all the people that owned land and worked on it directly plus those that owned land and made other people work on it. Landowners who

worked on their land but also on someone else's property were not counted. This measure is more restricted as the one made in (Demonet, 1990) who also included farmers and sharecroppers in this category.

Land value : measured as the mean, in franc per hectare, of four land values considered relevant to describe agricultural land. Namely, ploughable land, vineyards, pastures and forests. In the original data, these lands were decomposed in three quality classes whose repartition in the total land is unknown. Each value is taken as an average value over these three classes.

Agricultural area : in hectares, taking the same four types of land that are used to measure land value.

Food percentage in day-workers spendings : for a day-worker family of five members, food spendings (bread, vegetables, meat, milk, wine, cider, beer and salt) as a percentage of all spendings (food plus accommodation, clothing, heating, taxes and diverse spendings).

Number of animals : taken as the sum of wool animals (rams, sheep, ewes, lambs), pigs, billy goats, goats, young goats and horn animals (bulls, ox, cows, bull-calves, steers, heifers). Horses are excluded from this category as they were mainly bred in the wealthy north-est part of France.

Geographical data from the Institut Géographique National

Average altitude : in meters.

Surface area of municipalities : in hectares.

Postal Survey

Population dispersion : taken as the share of the total population that didn't match the contiguity criterion. See (Roncayolo, 1987) on this point.

Total population : taken from this survey if missing in the Guizot Survey.

Statistique générale de la France

Number of children : 5-15 years old children, taken from the 1851 French Census.

Population in 1793 and 1836

Industrial activities and schools' presence

Table 2.A4: Primary schools, demographic and geographic characteristics, means and t-tests

	No primary school	Primary school	t-test
Population - 1793	623	958	***
Population - 1833	731	1167	***
Average altitude	226.7	195.1	***
Surface area	1725.6	1725.5	NS
Population scattered (%)	58.9	37.8	***

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Guizot and postal surveys, IGN data.

Notes: The average population of municipalities with no primary school was 623 inhabitants in 1793. There were on average 958 inhabitants in towns where at least one primary school is present. The difference is significant at a one-percent level.

Table 2.A5: Presence of factories and primary schools

	No industry	Industry	Total
No primary school	3098	195	3293
	43.1	20.9	40.5
	94.1	5.9	100.0
Primary school	4098	738	4836
	56.9	79.1	59.5
	84.7	15.3	100.0
Total	7196	933	8129
	100.0	100.0	100.0
	88.5	11.5	100.0
Observations	8129		

Pearson $\chi^2(12) = 168.1641$ Pr = 0.000.

Source: Guizot and industrial surveys.

Notes: There were 3098 cases of municipalities with no primary school and no factory. 43.1% of the municipalities with no factory had also no primary schools. 94.1% of the municipalities in which there was no school were also characterised by the absence of factories.

Table 2.A6: Industrial (large) factories and primary schools. Logit, odds-ratio

Dependent variable: Primary School									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	1.190 (1.025)	–	–	1.783*** (4.014)	–	–	1.114 (0.723)	–	–
Number of factories	–	1.117 (1.628)	–	–	1.244*** (3.136)	–	–	1.066* (1.690)	–
Factories > 20 workers	–	–	1.270 (1.137)	–	–	1.716*** (3.134)	–	–	1.112 (0.558)
Agricultural controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	No	No	No	No	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	No	No	No	No	No	No
Number of clusters	79	79	79	88	88	88	88	88	88
Observations	6234	6234	6234	6621	6621	6621	6621	6621	6621
Pseudo- R^2	0.364	0.364	0.364	0.174	0.173	0.172	0.309	0.309	0.308

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: *Primary school* is an indicator variable which takes value 1 if at least a primary school was located in the municipality at stake. *Industry* and *Factories > 20 workers* are also dummy variables taking value 1 if a manufacture (more than 20 workers) was present in the given municipality.

Table 2.A7: IV estimation - Industrial activities and primary schools. Robustness check on potential outliers

Dependent variable: Primary School									
Bottom 90%:	Nb of factories			Production value			Population		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Industry	0.397* (1.843)	0.409* (1.905)	0.348* (1.792)	0.435* (1.871)	0.437* (1.893)	0.385* (1.839)	0.398* (1.793)	0.427* (1.918)	0.350* (1.761)
Agricultural controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Demographic and geographic controls	Yes								
Department fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
District fixed effects	Yes	No	No	Yes	No	No	Yes	No	No
Number of clusters	91	88	88	91	88	88	91	88	88
First-stage, dependent variable is the presence of industrial activities									
Presence of ore	0.148*** (4.32)	0.167*** (4.91)	0.164*** (4.79)	0.141*** (4.31)	0.156*** (4.59)	0.155*** (4.54)	0.146*** (4.22)	0.163*** (4.77)	0.160*** (4.64)
Observations	6599	6594	6594	6609	6605	6605	6602	6597	6597
R^2	0.148	0.043	0.096	0.149	0.046	0.098	0.154	0.044	0.100
$F - stat$	8.420	14.918	11.015	7.586	13.088	9.793	7.607	13.543	9.865
Regression-based p-value	0.068	0.140	0.086	0.063	0.141	0.081	0.067	0.132	0.086

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the location of primary schools in a given municipality. Estimations are restricted to municipalities with no more than six factories, an annual industrial production value inferior to 1 492 608 francs and a population lower than 4 875 inhabitants. This corresponds to the bottom 90% in terms of number of factories, production value and population for municipalities with a deposit and a factory.

Table 2.A8: IV estimation - Industrial factories and primary schools. Robustness check with population measured in 1833

	Dependent variable: Primary School		
	(1)	(2)	(3)
Industry	0.393*	0.397*	0.332*
	(1.789)	(1.837)	(1.672)
Agricultural controls	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes
Department fixed effects	No	No	Yes
District fixed effects	Yes	No	No
Number of clusters	91	88	88
First-stage, dependent variable is the presence of industrial activities			
Presence of ore	0.149***	0.165***	0.164***
	(2.86)	(3.74)	(3.29)
Observations	6723	6718	6718
R^2	0.156	0.051	0.105
$F - stat$	8.112	13.860	10.729
Regression-based p-value	0.073	0.135	0.069

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the location of primary schools in a given municipality. Population in 1833 instead of 1793 is included in these estimations.

Table 2.A9: GMM estimation - Industrial activities and primary schooling. Robustness check accounting for spatial autocorrelation

Spatial std. errors:	Dependent variable: Primary School							
	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry	0.427*	0.371*	0.427*	0.371*	0.427*	0.371**	0.427*	0.371**
	(0.216)	(0.202)	(0.216)	(0.202)	(0.216)	(0.202)	(0.216)	(0.202)
	[0.225]	[0.205]	[0.223]	[0.197]	[0.222]	[0.185]	[0.226]	[0.182]
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
District fixed effects	No	No	No	No	No	No	No	No
Observations	6621	6621	6621	6621	6621	6621	6621	6621

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ *Source:* Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: The spatial GMM estimations rely on the presence of iron, copper and coal deposits as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 2.A10: GMM estimation - Large factories and primary schooling. Robustness check accounting for spatial autocorrelation

Spatial std. errors:	Dependent variable: Primary School							
	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factories > 20 workers	0.481*	0.434*	0.481*	0.434*	0.481*	0.434**	0.481*	0.434**
	(0.242)	(0.234)	(0.242)	(0.234)	(0.242)	(0.234)	(0.242)	(0.234)
	[0.259]	[0.241]	[0.259]	[0.226]	[0.256]	[0.210]	[0.263]	[0.206]
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
District fixed effects	No	No	No	No	No	No	No	No
Observations	6621	6621	6621	6621	6621	6621	6621	6621

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ *Source:* Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: The spatial GMM estimations rely on the presence of iron, copper and coal deposits as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 2.A11: IV estimation - Industrial factories and primary schools. Robustness check with no textile factories

	Dependent variable: Primary School		
	(1)	(2)	(3)
Industry	0.376*	0.396*	0.346*
	(1.681)	(1.719)	(1.677)
Agricultural controls	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes
Department fixed effects	No	No	Yes
District fixed effects	Yes	No	No
Number of clusters	90	87	87
First-stage, dependent variable is the presence of industrial activities			
Presence of ore	0.148***	0.160***	0.158***
	(4.35)	(4.81)	(4.73)
Observations	6452	6447	6447
R^2	0.144	0.046	0.096
$F - stat$	8.172	12.989	10.287
Regression-based p-value	0.106	0.185	0.118

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.
Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the location of primary schools in a given municipality. Textile factories are excluded from the estimations.

Income effect

Table 2.A12: Industrial factories and investment in primary education, means and t-tests

	No industry	Industry	t-test
Fixed salary (percentage of municipalities)	37	53	***
Fixed salary amount (in francs per year)	83.5	201.9	***
Accommodation (percentage of municipalities)	27	40	***
Accommodation allowance (in francs per year)	5.2	11.5	***
Classroom (percentage of municipalities)	31	45.2	***

Taking into account only the municipalities with schools

Fixed salary amount (in francs per year)	146.6	262.3	***
Accommodation allowance (in francs per year)	9.1	14.9	***

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Guizot and industrial surveys.

Notes: In 37% of the municipalities with no industry, a teacher was granted with a fixed salary. The average fixed salary was of 83.5 francs per year in municipalities with no industry. This average salary was of 146.6 francs when the sample is restricted to municipalities with a school.

Table 2.A13: IV estimation - Industrial factories and fixed salary.

	Dependent variable : Fixed salary		
	(1)	(2)	(3)
Industry	0.402*	0.479*	0.383*
	(1.846)	(1.861)	(1.852)
Agricultural controls	No	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes
Department fixed effects	No	No	Yes
District fixed effects	Yes	No	No
Number of clusters	91	88	88
First-stage, dependent variable is the presence of industrial activities			
Presence of ore	0.144***	0.162***	0.160***
	(4.20)	(4.76)	(4.65)
Observations	6626	6621	6621
R^2	0.155	0.047	0.101
$F - stat$	7.925	14.024	10.321
Regression-based p-value	0.069	0.080	0.069

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN and BRGM data.

Notes: The instrument is the presence of iron, copper and coal deposits. The dependent variable is always the presence of a teacher paid on a regular annual basis in a given municipality.

Table 2.A14: GMM estimation - Industrial activities and fixed salary provision. Robustness check accounting for spatial autocorrelation

Spatial std. errors:	Dependent variable: Fixed salary							
	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry	0.479*	0.383*	0.479*	0.383*	0.479*	0.383**	0.479*	0.383**
	(0.228)	(0.200)	(0.228)	(0.200)	(0.228)	(0.200)	(0.228)	(0.200)
	[0.258]	[0.217]	[0.264]	[0.204]	[0.256]	[0.187]	[0.258]	[0.183]
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
District fixed effects	No	No	No	No	No	No	No	No
Observations	6621	6621	6621	6621	6621	6621	6621	6621

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ *Source:* Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: The spatial GMM estimations rely on the presence of iron, copper and coal deposits as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 2.A15: GMM estimation - Large factories and fixed salary provision. Robustness check accounting for spatial autocorrelation

Spatial std. errors:	Dependent variable: Fixed salary							
	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Factories > 20 workers	0.540*	0.448*	0.540*	0.448**	0.540**	0.448**	0.540**	0.448**
	(0.239)	(0.231)	(0.239)	(0.231)	(0.239)	(0.231)	(0.239)	(0.231)
	[0.290]	[0.250]	[0.280]	[0.225]	[0.270]	[0.202]	[0.271]	[0.198]
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
District fixed effects	No	No	No	No	No	No	No	No
Observations	6621	6621	6621	6621	6621	6621	6621	6621

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ *Source:* Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: The spatial GMM estimations rely on the presence of iron, copper and coal deposits as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 2.A16: Industrial production, taxes and primary schooling, means and t-tests

	No primary school	Primary school	t-test
Taxes on industrial activities (in francs per year)	21.2	114.1	***
Industrial production value (in francs per year)	11 069.3	97 535	***
	No fixed salary	Fixed salary	t-test
Taxes on industrial activities	60	123.2	**
Industrial production value	44 675.3	113 658.3	***
	No accommodation	Accommodation	t-test
Taxes on industrial activities	51.4	167.4	***
Industrial production value	38 486.7	154 199.5	***

*** p<0.01, ** p<0.05, * p<0.1.

Source: Guizot and industrial surveys.

Notes: In the municipalities in which no primary school was present, taxes on industrial activities amounted on average to 21.2 francs per year. This low figure is explained by the fact that in many municipalities, no manufacture was present. These cases are counted as zero value in the computation of the average taxes. Focusing on municipalities with industrial activities would lead to higher figures. The average level in municipalities with a primary school amounted to 114 francs. The difference is significant at a one-percent level.

Table 2.A17: Industrial production, taxes and large factories, means t-tests

	Industry < 20 workers	Industry > 20 workers	t-test
Taxes on industrial activities (in francs per year)	125.8	1 179.4	***
Industrial production value (in francs per year)	94 186	1 006 482	***

*** p<0.01, ** p<0.05, * p<0.1.

Source: Industrial survey.

Notes: In municipalities with factories less than 20 workers, taxes on industrial activities amounted to 125.8 francs per year on average. In towns with manufactures more than 20 workers, they amounted to 1 179.4 francs on average. The difference between the two is significant at a one-percent level.

Table 2.A18: Fixed salary, fixed salary amount and industrial taxes.

	(1)	(2)	(3)	(4)
	Fixed salary	Fixed salary	Salary amount	Salary amount
Taxes on industrial activities	0.058*	0.063**	27.584*	19.829*
	(1.678)	(2.637)	(1.895)	(1.900)
Agricultural controls	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes
Department fixed effects	No	Yes	No	Yes
Number of clusters	80	80	80	80
Observations	3663	3663	3663	3663
R^2	0.166	0.278	0.217	0.368

t statistics in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Agricultural, postal and Guizot surveys. IGN data.

Notes: Only municipalities with schools are taken into account. Taxes on industrial activities are only considered if at least one factory more than 20 workers was present in the municipality at stake. One standard deviation in the amount of industrial taxes was linked to an increase of around 6.3% in the probability for teachers to have a fixed salary. The effect on the amount of this salary was between 19 and 27 francs per year.

Industrial activities and the demand for schooling

Table 2.A19: Industrial factories and enrolment, means and t-tests

	No industry	Industry	t-test
Pupils per 100 inhabitants - Winter	9.9	6.9	***
Pupils per 100 inhabitants - Summer	4	3.6	***
Pupils per 100 inhabitants (mean)	6.6	5	***
Pupils per 100 inhabitants - Winter, < 2000 inhabitants	10.5	8.2	***
Pupils per 100 inhabitants - Summer, < 2000 inhabitants	4.4	3.8	***
Pupils per 100 inhabitants - Winter, > 2000 inhabitants	3.6	4.7	***
Pupils per 100 inhabitants - Summer, > 2000 inhabitants	2.1	3.2	***
	No industry > 20 workers	Industry >20 workers	t-test
Pupils per 100 inhabitants - Winter	9.7	7	***
Pupils per 100 inhabitants - Summer	4.1	3.6	**
Pupils per 100 inhabitants (mean)	6.5	5.1	***
Pupils per 100 inhabitants - Winter, < 2000 inhabitants	10.4	8.4	***
Pupils per 100 inhabitants - Summer, < 2000 inhabitants	4.4	3.8	**
Pupils per 100 inhabitants - Winter, > 2000 inhabitants	3.8	4.9	***
Pupils per 100 inhabitants - Summer, > 2000 inhabitants	2.4	3.3	***

*** p<0.01, ** p<0.05, * p<0.1.

Source: Guizot and industrial surveys.

Notes: In municipalities with no industrial factories, 9.9 children per 100 inhabitants were enrolled in primary schools in wintertime. 6.9 children were so in municipalities with industry at the same period. The difference is statistically significant at a one-percent level. Only municipalities with at least one primary school are taken into account.

Table 2.A20: Industrial sectors and percentage of children among workers

	Mean	Standard Deviation	Minimum	Maximum
Furniture	25.7	17.7	0	50
Textile	17.9	16.1	0	100
Luxury	13.8	20.1	0	66.7
Ceramics	11.3	12.6	0	66.7
Building	11.2	15.3	0	75
Science, letters and arts	11.2	14.9	0	75
Metal Objects	10.5	13.5	0	100
Metallurgy	6.4	9.7	0	58.6
Transports	6.3	10.7	0	50
Clothing	5.3	12.5	0	90
Mining activities	5.2	10.4	0	66.7
Wood	5	11.3	0	48.5
Leather	3.8	10.4	0	100
Lightning	3.5	10.6	0	66.7
Chemistry	3.4	9.9	0	76.9
Food	3	8	0	100
All sectors	10.5	14.6	0	100

Source: Industrial survey.

Notes: The average percentage of child workers among industrial workers at the national level in textile factories was 17.9, with a standard deviation of 16.1. The minimum percentage in this sector was zero, the maximum one hundred. Sectors are reported in decreasing order with respect to the mean.

Table 2.A21: Industrial sectors and industrial male workers' wage

	Mean	Standard Deviation	Minimum	Maximum
Luxury	260	84	110	475
Transports	254	75	130	425
Metallurgy	244	82	100	625
Metal Objects	233	93	75	660
Science, letters and arts	222	79	90	550
Furniture	220	63	125	335
Chemistry	215	62	75	450
Ceramics	213	76	85	500
Lightning	210	74	100	400
Wood	203	72	75	500
Mining activities	202	72	75	500
Food	198	66	50	550
Leather	195	51	75	650
Clothing	190	68	25	450
Building	182	54	75	450
Textile	178	64	25	600
All sectors	198	71	25	660

Source: Industrial survey.

Notes: The average wage of industrial male workers was 260 cents of francs in the luxury sector at the national level, with a standard deviation of 84 cents. The minimum wage reported was 110 cents in this sector and the maximum 475 cents. Sectors are reported in decreasing order with respect to the average wage.

Table 2.A22: Child-work intensive industrial sectors and industrial wages.

	Dependent variable : Daily industrial male wage				
	(1)	(2)	(3)	(4)	(5)
Sectors > 10% child workers	-16.764*	-14.096*	-14.098*	–	–
	(-1.798)	(-1.686)	(-1.867)		
Textile	–	–	–	-16.981*	–
				(-1.828)	
Building	–	–	–	–	-16.636
					(-1.589)
Agricultural controls	No	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	Yes	Yes	Yes
District fixed effects	Yes	No	No	No	No
Number of clusters	81	80	80	80	80
Observations	605	604	604	604	604
R^2	0.436	0.193	0.338	0.338	0.334

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: In these estimations, all dependent variables are dummies which equal 1 if industrial activities were located in a given municipality. The effect of the sectors in which the average percentage of child workers was superior to ten at the national level is measured, both gathering them into a dummy variable or taking them separately. This corresponded to furniture, textile, luxury, ceramics, building, science-letters and arts and metal objects sectors. The presence of these sectors was related to a fall in industrial male worker daily wage of around 14 cents of francs.

Table 2.A23: OLS estimations. Skill-biased technological change and primary schooling

	Primary school	Fixed salary	Enrolment rate		Number of subjects	Schooling years	Industrial production	Industrial taxes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Steam engines per 100 inhabitants	0.053 (0.305)	0.114 (0.598)	-1.042 (-0.696)	-1.244 (-0.758)	0.321 (0.341)	-0.252 (-0.240)	1169003.993*** (4.017)	1680.426*** (3.468)
Water engines per 100 inhabitants	-0.071** (-2.150)	-0.050 (-1.142)	-1.049 (-1.274)	-1.986*** (-3.316)	-0.477** (-2.213)	-0.413* (-1.797)	495326.859*** (5.276)	590.229*** (5.112)
Wind engines per 100 inhabitants	0.258 (1.000)	0.517 (0.883)	17.009 (1.136)	-6.629 (-0.673)	2.485 (0.610)	0.397 (0.098)	192327.439 (1.010)	1317.610 (1.286)
Animal-traction engines per 100 inhabitants	0.013 (0.059)	0.115 (0.501)	2.460 (0.793)	10.526** (2.061)	0.737 (0.486)	-0.136 (-0.120)	398203.407*** (3.077)	760.100*** (2.753)
Population	All	All	< 2 000	≥ 631	All	All	All	All
Agricultural controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic and geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District fixed effects	No	No	No	No	No	No	No	No
Number of clusters	88	88	79	80	88	88	88	88
Observations	6621	6621	3526	1916	6620	6465	6621	6621
R^2	0.354	0.356	0.576	0.660	0.376	0.474	0.317	0.230

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Agricultural, industrial, postal and Guizot surveys. IGN data.

Notes: Enrolment rate corresponds to the number of pupils per 100 inhabitants. Industrial production and industrial taxes are measured in francs per year.

Chapter 3: Education and economic development. The influence of primary schooling on municipalities in nineteenth-century France

Abstract

The impact of education on growth or individual earnings has been vastly studied in economics. However, much remains to know about this association before the mid-20th century. In this article, I investigate the effect of primary schooling on the economic development of French municipalities during the 19th century and up to World War I. Before the Guizot Law of 1833, no national legislation on primary schooling existed in France. Therefore, I evaluate if the municipalities with higher educational achievements before this law grew more than their counterparts during the following years. To do so, I exploit first the fact that the Guizot Law forced municipalities over 500 inhabitants to open and fund a primary school for boys. I implement a regression discontinuity around this cut-off on municipalities with no primary school in 1833. Second, I instrument educational achievement, namely enrolment rates and schooling years, by the proximity of municipalities to printing presses established before 1500. Each method returns a positive impact of education on development. Education quality also mattered in this perspective. A matching estimation on municipalities with a school in 1833 indicates a positive impact of better teaching conditions provided by public grants on the subsequent growth of municipalities. Primary schooling, and therefore the acquisition of "basic" or elementary skills, is therefore an important factor which favoured the development of French municipalities during the century of industrialisation and modernisation.

1 Introduction

The contribution of human capital to economic growth is an ongoing and debated topic. Theoretically, education has been analysed as a potential driver of long-term sustained growth in the endogenous growth literature (Lucas, 1988), (Romer, 1990), or as a mere factor of production in neo-classical models (Mankiw et al., 1992)¹⁵⁸. Empirically, there also has been a debate on whether the level or the change in education would impact growth. Early studies, in line with the endogenous growth literature, found a positive influence of educational levels and not changes (Romer, 1990), (Benhabib and Spiegel, 1994). However, they have been criticised on the basis of measurement errors in education which could impact more strongly changes in variables than levels (Krueger and Lindahl, 2001). More recent studies have identified a positive link between both the level and the changes in education with economic growth (Gemmell, 1996), (Krueger and Lindahl, 2001). Finally, improving the original Barro-Lee data on schooling years (Barro and Lee, 1993) had led scholars to conclude about a positive and significant impact of changes in education (de la Fuente and Doménech, 2006), (Cohen and Soto, 2007), (Ciccone and Papaioannou, 2009). These studies focused on the 1960-2000 time period, using country-level data in a macroeconomic setting¹⁵⁹. Recent studies also exhibited a positive link between education years and regional development (Gennaioli et al., 2013).

Another branch of the literature focused rather on the impact of education on individual earnings at the micro level. From the early work of Mincer (Mincer, 1958), (Mincer, 1974), it has been shown that the return to one additional year of education was lying between 6 and 10%, depending on the estimation strategy adopted. Instrumental variable estimations, using either the unequal access to education (Angrist and Krueger, 1991), (Angrist and Krueger, 1992), (Card, 1993) or a comparison between twins (Ashenfelter and Krueger, 1994), (Miller et al., 1995), (Ashenfelter and Rouse, 1998), (Isacsson, 1999) have been used to this end¹⁶⁰. This literature also focused mostly on the post-World War II era and, to a lesser extent, on the early 20th century (Goldin and Katz, 2000).

In this paper, I evaluate the contribution of education to economic development in nineteenth-century France and until World War I. Compared to most of the existing studies, I adopt a long-term historical perspective to evaluate the relation between instruction and growth. I also focus on a century marked by major economic changes, industrialisation and modernisation. Primary schooling is the level of education under scrutiny in this work. Up to the Guizot Law of 1833, there was no strong national supervision of primary schools in France. Teachers could almost freely settle in any municipality and start practising. In this context, primary instruction developed quite heterogeneously over the French lands, with a clear educational advantage for

¹⁵⁸See also (Azariadis and Drazen, 1990) for an elaboration of the Diamond model and (Topel, 1999) for a review of the literature.

¹⁵⁹The positive and significant impact of education on growth has been more deeply questioned in other studies pointing out its potentially over-estimated impact (Klenow and Bils, 2000), (Pritchett, 2001).

¹⁶⁰Discontinuities in mandatory schooling years have also been used to measure the returns to education (Harmon and Walker, 1995). See (Card, 1999) or (Ashenfelter et al., 1999) for a literature review on returns to schooling.

the regions located north of a line going from St-Malo to Geneva (Dupin, 1826), (Fleury and Valmary, 1957), (Houdaille, 1977). But did this make a difference in terms of economic growth? And if so, how large was the association between education and development? I focus on primary schooling since only half of the men were literate in France at the beginning of the 19th century, and less than one-third of the women. It is at this level that a strong convergence took place during this century, with a mass movement of increase in literacy. Therefore, it is interesting to evaluate how primary education interacted with economic development during the 19th century.

To explore these questions, I focus at the disaggregated level of municipalities, using a newly constituted database collected just before the passing of the Guizot Law. These data cover 22 departments and more than 8 000 municipalities. Therefore, I don't compute individual returns to schooling, nor growth rates at the more aggregated level of departments. What I am mainly interested in is to evaluate if an early investment in primary schooling at the municipal level (therefore before 1833) had an impact on the subsequent development of these very municipalities. The amount of taxes per capita collected in municipalities in 1881 and 1911 is the measure used to approximate their economic resources and development. As a consequence, this work lies between the micro and macro-level studies on human capital and is methodologically close to urban economics articles focusing on the impact of human capital on the population and economic growth of cities (Glaeser et al., 1995), (Simon and Nardinelli, 2002), (Glaeser, 2003), (Glaeser et al., 2004).

I make use of different estimation strategies to link primary education to economic development. First, I use a feature of the Guizot Law to implement a regression discontinuity. The law made mandatory for each municipality more than 500 inhabitants to open and fund a primary school for boys. I therefore select municipalities without primary schools in 1833 close to this population cut-off to investigate the impact of education on economic resources. I find a positive effect, with a magnitude close to 2 francs per capita. This corresponds to around one-third of a standard deviation in municipal resources.

These outcomes are complemented and supported by an instrumental variable (IV) strategy. Primary schooling achievements were higher in the north-eastern part of France, close to the city of Mainz where the printing press was first introduced by Johannes Gutenberg around 1450. The distance to this city has already been used to instrument primary schooling expansion (Diebolt et al., 2017b). In this work, I select two different instruments, the distance between municipalities and the nearest printing press established in 1500, along with the number of printing presses in 1500 within a given radius around municipalities (100 kms most of the times). I find a strong association between them, enrolment rates and the average schooling years within primary schools. There is no significant relation between the printing press and the previous population growth of municipalities, taken as a proxy for economic development, or their industrial and postal characteristics around 1840. The same is true for the relation between the press and the economic resources of departments in the early 19th century. I explain more deeply in the paper why these results are not at odds with Dittmar, 2011. This

strategy exhibits a strong and positive link between schooling years, enrolment rates and the economic resources of municipalities. One additional year of schooling in a given municipality was associated with a 15% increase in economic resources at the end of the century. A one-percent increase in enrolment with a 0.4% increase in resources. These two measures can be taken as fairly good proxies for human capital accumulation in the early nineteenth-century France (Montalbo, 2019b).

Finally, in relation with the recent literature about the impact of schools' and teachers' quality on education and development (Hanushek, 2011), (Hanushek and Woessmann, 2008), I use a matching estimation to explore the effect of primary schooling quality. I find a positive association between the financial stability provided to teachers by municipal investment in education and the subsequent level of economic resources. Teachers' level of certification was however not significantly linked to development when controlling by enrolment and schooling years.

In this paper, I also discuss the potential transmission channels between education and economic development during the nineteenth century. More jobs were requiring to master at least literacy during its second part, which can explain part of this association. Also, the diffusion of technological progress may have been faster in municipalities where education was more developed, especially in the agricultural sector. Lastly, primary schooling may have attracted people with a higher preference for education. These migrations might therefore have in turn reinforced the positive effect of instruction on workers' productivity by increasing the share of educated people within a given municipality.

This article contributes to the literature on human capital by investigating its association with economic development in the age of industrialisation and modernisation. Indeed, the 19th century, and especially its second part, was characterised by a surge in industrial activities in France. Moreover, the agricultural sector saw its apogee at that time before entering a phase of crisis from the 1880s to the World War I (Duby and Wallon, 1976). This paper is therefore directly linked to studies which found a positive association between education and growth in the pre-industrial era (Cipolla, 1969), (de Pleijt, 2018). High educational achievements have notably been associated to the Little Divergence between England, the Low Countries and the rest of Europe over the 1300-1800 time period (Baten and van Zanden, 2008), (de Pleijt and Zanden, 2016)¹⁶¹. The association is however not valid for all European countries (Sandberg, 1979). In the case of France, (Squicciarini and Voigtländer, 2015) also show a positive effect of upper-tail knowledge on city growth and industrial performance during the onset of industrialisation.

However, these articles focus on the pre-19th century period and mostly on upper-tail knowledge without providing a measure of primary schooling achievement. Literacy rates taken as a proxy for schooling are then often found not to have been significantly linked to growth over the period under scrutiny. This paper sheds a new light on a potential missing factor which contributed to the growth of municipalities during the era of modernisation, namely primary

¹⁶¹See also (van Lottum and van Zanden, 2014) on the importance of skills in the maritime sector before the industrialisation.

education¹⁶². As for industrial development in nineteenth-century Prussia (Becker et al., 2011), (Cinnirella and Streb, 2017) "basic" or "average" education mattered for economic development in France. If upper-tail knowledge favoured industrialisation up to the mid-nineteenth century, basic education appears to be essential in accounting for the growth of municipalities during this century.

The next section presents some historical facts about primary schooling and economic development in nineteenth-century France. Section 3 is a description of the data I use while Section 4 presents the results from the regression discontinuity design approach. Instrumental variable outcomes are presented in Section 5 while the influence of education quality on economic development is studied in Section 6. In Section 7, I discuss the potential transmission channels between primary education and economic development. Section 8 concludes.

2 Primary Education and Economic Development Over the Century

The Guizot Law was passed on the 28th of June 1833, making compulsory for any municipality over 500 inhabitants to open and maintain a primary school for boys. Teachers were also to be paid on a regular basis, not less than 200 francs a year. This law was the first major step towards universal schooling undertaken in France. To this date, the decision to open a primary school (along with paying the teacher on a fixed basis or not, how much, buying books, blackboards and other pieces of furniture, providing the teacher with an accommodation or a classroom,...) was mainly made at the level of municipalities¹⁶³. Local authorities thus played an important role, along with parents who were in most cases (except when they were listed as indigents by the municipality or when the school was totally free, which was extremely rare at that time) paying fees so that their children could attend school. Before the passing of the law, primary schools were divided into two types. Those only financed by the monthly tuition fees paid by families to the teachers were said to be private. When municipalities were investing in schools, by paying teachers or providing them with a classroom or an accommodation for example, the schools were said to be public.

In this context, primary schooling developed differentially across regions (Kennedy and Netter, 1981). From the early work of the Dupin baron, an opposition has been drawn between a well-educated France above the Saint-Malo/Geneva line and a less-educated one below (Dupin,

¹⁶²It is therefore also close to development economics articles focusing on the recent contribution of primary schooling to growth and earnings. See for example (Duflo, 2001) or (Glewwe and Jacoby, 2004).

¹⁶³A precise description of the daily life of schools and teachers in the eighteenth and early nineteenth centuries can be found in (Duveau, 1957). Analyses or testimonies on the state of primary schooling by teachers from the early nineteenth century are available in (Lorain, 1837) and (Meunier, 1981). In order to have an analysis of local schooling development in the eighteenth century, see for example (Vovelle, 1975) or (Laget, 1971). See (Gildea, 1983) for a local study from 1800 onwards for the departments of Ille-et-Vilaine, Gard and Nord. In order to have a full political analysis and a description of the laws, projects, and debates about primary instruction during this period of time, one can refer to (Gontard, 1959), (Mayeur, 2004) and the second and third chapters in (Furet and Ozouf, 1977a).

1826). For example, in the 1820s, the enrolment per 100 children six to thirteen years of age was higher north of the line, with a mean of 94, compared to south of it, with an average level of 53. This was also true for the schooling of girls (Grew and Harrigan, 1991). Figure 3.1 depicts this distinction between French departments. Therefore, before the Guizot Law, primary schools and high enrolment rates were mostly concentrated in the north-east part of France, even if some other regions as the Rhône Valley and the Gironde were also characterised by rather good schooling levels. This pattern remained stable at least until the 1860s in France, even if a convergence in educational attainment was already at work before the Ferry Laws of 1881-1882 (Diebolt et al., 2005), which made primary schooling compulsory. The number of children schooled per 10 000 inhabitants, for example, still followed closely the geographical distribution described in the mid-1850s and mid-1860s. The same is true for percentage of women or men signing their marriage license in 1871-1875.

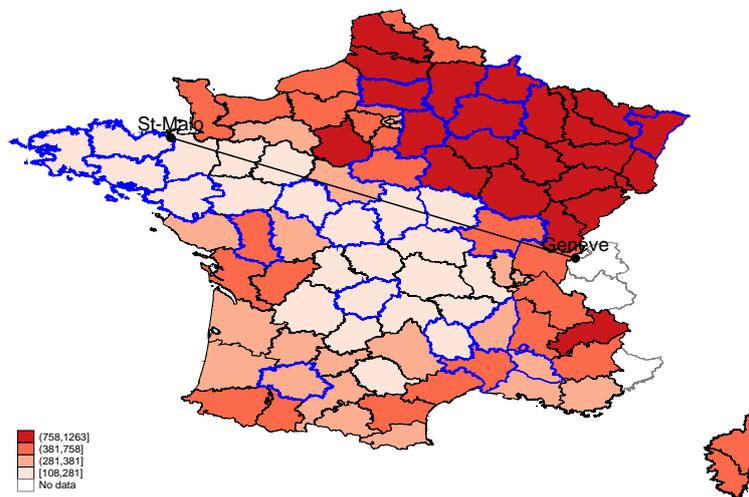


Figure 3.1: Number of pupils attending primary schools - winter 1833 (over 10 000 inhabitants)

Source: (Motte et al., 2003), Guizot survey - Report to the King.

Note: Departments in blue are the ones for which education data are available at the level of municipalities.

The schooling of girls followed a different path as, until late into the 19th century, numerous religious congregations were in charge the schooling of girls. For example, the *Ursulines* in the south-east, the *Filles de Notre-Dame*, the *Sœurs de la Charité de l'instruction chrétienne* or the *Filles de la Visitation* within the Parisian region (Mayeur, 2004). But for the majority of them, no education was provided outside of the family sphere. They were not supposed to be taught along with boys within primary schools. However, it was common to gather both sexes when economic resources were too scarce to create two distinct schools¹⁶⁴. It is only with the Falloux Law of 1850 that the opening of a primary school for girls in municipalities more than

¹⁶⁴At the time of the passing of the Guizot Law, separated primary schools for girls were still rare. Victor Cousin described them as "almost luxury schools" before the Chamber of Deputies in 1833.

800 inhabitants was made compulsory. The Duruy Law of 1867 lowered the threshold to 500 inhabitants. The Ferry Laws then applied to girls too.

The nineteenth century was, for most Western countries, a period of economic modernisation and growth. Industrial production began to grow substantially from 1815 onwards in France, with an annual rate of 3% for the best years (Lévy-Leboyer, 1968) compared to around 0.5% between 1781-1790 and 1803-1812 (Crouzet, 1996). The highest rates were attained at the end of the July Monarchy and under the Second Empire. They subsequently dropped below their average value over the century after 1882 (Crouzet, 1970). This growth remained however quite gradual all over the century, which led some authors to deny the idea of a real industrial take-off in France (Mendels, 1972)¹⁶⁵. According to the Industrial survey of 1861-1865, textile and food industries were clearly the leading sectors even in the second part of the century. They represented respectively 31.4% and 20.8% of industrial value-added, against around 6% for extractive industries and 5% for the metallurgy (Verley, 1997)¹⁶⁶.

The geography of industrial activities also evolved during this century. Data from the 1839-1847 Industrial survey show that manufactures were mostly concentrated in the north-west and western departments close to the Atlantic Ocean in the first part of the century. This concentration was associated to the volume of commercial activities in Atlantic ports like Le Havre, La Rochelle or Nantes (Asselain, 1984). Big manufactures and steam engines were on the contrary more concentrated in the north and north-eastern parts of France, along with the Rhône Valley. This was associated to the progressive surge of mining and metallurgic sectors in France at that time, in particular to the exploitation of coal and iron. Deposits were indeed highly concentrated in the Nord-Pas-de-Calais, Lorraine, Auvergne, Loire, Dauphiné, Provence and Cévennes areas in France. In some regions as Normandie or the Dauphiné, the concomitant presence of rivers, forests and deposits explains the ancient presence of metallurgic sectors (Léon, 1948), (Richard, 1962), (Kellenbenz, 1963). Textile activities also followed closely this geographical pattern (Dunham, 1953).

Industrial activities were negatively affected by a general downturn towards the end of the century as the 1880s were particularly bad for French economy. Rural industry was severely altered by this crisis. Indeed, it had first to face the competition of cheaper British products

¹⁶⁵This idea, along with the level of industrial performance of the French economy, have been greatly debated. They have been deemed low and stagnating compared to Great-Britain in the 1940s and 1950s, before a revisionist literature insisted on the relatively good economic performance of France during the 19th century and on the distinctive path of growth this country followed (Crouzet, 1966), (O'Brien and Keyder, 1978). This point of view has subsequently been qualified by authors amending the figures on French productivity growth and insisting anew on the difficulties known by the agricultural and industrial sectors compared to the British ones (Crafts, 1977), (Crafts, 1984). See (Lévy-Leboyer, 1978) for an analysis of French industrial investment and (Lévy-Leboyer and Bourguignon, 1985) for a macro-economic analysis of French economy along the century. See (Crouzet, 2003) for a historiography of French economic growth during the 19th century, from the "retardation-stagnation" thesis to the "moderate revisionism". To have an economic analysis and description of the industrialisation period in France and other European countries over the century, see (Braudel and Labrousse, 1976), (Verley, 1999) and (Verley, 1997). For an analysis of the French case under the *Ancien Régime*, see for example (Sée, 1925) or (Woronoff, 1998).

¹⁶⁶The same was true when taking into account the percentage of the industrial labour-force in each sector. 50% was working in the textile sector at that time, 13% in the building one and 14% in the metallurgy (Noiriél, 2002).

after the free-trade treaty of 1860. Second, the growing unification of the national French market enhanced by the development of rail-roads increased the competition between large and small factories. This contributed to the progressive de-industrialisation of southern France, unable to compete with the triumphant metallurgic manufacturers of the northern and eastern regions. The concomitant agricultural crisis also reduced the purchasing power of rural inhabitants and therefore the outlets for industrial production. All of this favoured the migration and concentration of industrial workers in towns, which participated in the creation of the French industrial working class (Noiriel, 2002).

Agriculture still remained the sector gathering the highest share of the labour-force in nineteenth-century France. The 1851 census indicates for example that 53.2% of the total population was belonging to a farming family (Demonet, 1990). In 1881, 47.5% of the labour-force was concentrated in the agriculture, against 26.7% in the industry and 24.9% in services. The farms were most of the times small in France at that time. Their average surface area was of 12 hectares in the mid-19th century, but in half of the departments, half of the farms were less than 5 hectares.

Agricultural production increased by 75% in France between 1815 and 1852. The highest growth rates were concentrated under the July Monarchy and were mainly due to the dynamism of livestock farming. The production increased by 80% between 1852 and 1882 before being struck by a severe downturn as for the industry. This phenomenon characterised most of all root crops as sugar beets and potatoes whose cultivated surface area increased respectively by 116% and 61%. This was partly due to a growing individual consumption. Over the period, for example, the average annual consumption of wheat per capita increased by 34%, that of potato by 40% at least, the consumption of sugar by 118% and of meat by 40%. Livestock farming and wine production also peaked in the mid-1870s. Vineyards represented for example 2.5 millions of hectares in 1874. Cereal production was on the contrary stagnating at that time. (Duby and Wallon, 1976).

The evolution was however far from being homogeneous as some regions were already characterised from the 1830s onwards by the rural exodus of their population. This was especially the case for the Massif Central, Lorraine, Alsace, the alpine department and the wooded countryside of Normandie, Maine and Jura. The growth of agricultural production characterised most of all the regions located south of the line going from St-Malo to Geneva. Moreover, the trade balance remained in deficit for many agricultural products. Productivity growth stagnated and a large part of the increase in production appears to have been due to rising prices.

The end of the century downturn is due to several factors. First, a number of specific crises, as the phylloxera in wine and a series of diseases in silk farming. Second, the globalisation of trade and increased competition affected negatively agricultural prices. Third, rural exodus accentuated strongly in the second part of the century, especially in peripheral areas. 55 departments knew a negative evolution of their population between 1881 and 1911, 62 of them between 1901 and 1911. Rural population went from 74.5% to 64.1% and 55.8% of the total

population in 1851, 1866 and 1911 (Beltran and Griset, 1994)¹⁶⁷. In this context, agricultural production declined for all products, except for potato and fodder crops. The political reaction to this crisis was a return to more protectionism, notably embodied by the Meline Law in 1892 which increased customs duties on agricultural products.

3 Data

3.1 Data on Education

In 1833, when the Guizot Law was passed, a survey at the national level was conducted in order to evaluate the state of primary schooling in France, under the supervision of the French Minister of Education, François Guizot¹⁶⁸. 490 inspectors were sent throughout France in autumn 1833. All primary schools, both public and private, were to be examined. However, primary schools to which only girls were attending were excluded from the scope of the survey as the Guizot law didn't apply to them. All departments were inspected, except Corsica.

Data coming from the Guizot Survey of 1833 was published for all French districts in a *Report to the King* (Guizot, 1834). These districts (*arrondissements départementaux* or *sous-préfectures*) correspond to an administrative subdivision of departments (counties). Two to six of them existed in each department. Only some of the questions asked in the initial survey, those deemed of major interest, were aggregated in this report. From the initial individual (at the level of each primary school) forms, the data were collected for 22 departments and 8 129 municipalities¹⁶⁹. This study will however be made on 21 departments. Indeed, the Bas-Rhin department was not belonging to France any-more after the 1870 Franco-Prussian War. Data on its economic resources are therefore not available at the end of the century. At least one primary school was present in 4 836 of the municipalities (59.5%). This project has been initiated by the *Service d'Histoire de l'Education* of the I.N.R.P, which collected data for the academies of Nantes, Bourges and Nîmes. Other departments were then added to this initial database. In Figure 3.1, one can see that these departments (in blue) belong to areas with very different levels of enrolment. The Brittany region and the centre part of France with very low levels of enrolment are well represented in the sample. So are the highly educated north-east and the southern part of the country where education was more unevenly distributed, with five departments for each area. To sum up, around 20% of the departments above the St Malo-Geneva line are represented in the sample, against 25% of those below the line¹⁷⁰. This should ensure a high variation in terms of education and a good representativeness of the data used. Their collection was indeed conducted with the aim of catching all the determinants that

¹⁶⁷On this point, see also (Molinier, 1977).

¹⁶⁸A lot of information on this survey is available here : <http://www.inrp.fr/she/guizot/>.

¹⁶⁹These departments are: Ardèche, Ardennes, Cher, Corrèze, Côtes-du-Nord (Côtes D'Armor), Finistère, Gard, Gers, Indre, Indre-et-Loire, Loire-Inférieure (Loire Atlantique), Loiret, Lozère, Marne, Morbihan, Nièvre, Oise, Bas-Rhin, Saone-et-Loire, Seine-et-Marne, Deux-Sèvres and Vaucluse. At that time, there were 86 departments. Current denominations of departments are specified in brackets when a change occurred.

¹⁷⁰Excluding the three departments located on this very line.

underpinned primary schools spreading. This, added to the focus at the municipal level, should help avoiding some of the criticisms that were pronounced against the reliance of aggregated historical data on primary schools¹⁷¹. Other data on education are coming from the *Statistique générale de la France*.

The departments selected are quite representative of France for what regards primary education and economic characteristics in the first part of the nineteenth century. Taking average values at the level of districts in order to compare this "municipal level sample" to the entire country thanks to the *Report to the King*¹⁷² shows that the number of (public) primary schools doesn't differ significantly between the sample and the entire country. However, enrolment rates and the percentage of municipalities with schools (60.8% against 71.5% for France) are lower in the sample, which means that the departments at stake were less well-endowed in primary schools than at the national level.

Taking data on the height of 20-years old military conscripts to proxy economic resources¹⁷³ shows that the departments in the sample were close to the average national level. When considering industrial factors, the sample differs significantly only in the percentage of municipalities with factories (21.6% against 17.2% for France). The number of workers, their average wages, the amount of industrial production or the presence of large factories (more than 20 workers, the top one-third in terms of size) didn't differ significantly between France and the municipality sample. Finally, using the Agricultural survey of 1852 shows no strong difference France and the municipality sample. Either in terms of agricultural area, production organisation or wages, the sample is quite comparable to the national averages.

3.2 Data on Economic Resources

In this article, the economic variable of interest is the amount of taxes per capita collected by municipalities. These data are coming from publications by the Ministry of the Interior entitled *La Situation Financière des Communes de France et de l'Algérie*¹⁷⁴, issued each year from 1878 to 1929. I digitalised the 1881 and 1911 years in order to have a measure of the economic resources of municipalities at the end of the growth phase in nineteenth-century France and just before World War I¹⁷⁵. I selected two years for several reasons. First, it enables me to

¹⁷¹See for example on this point the criticisms made in (Luc, 1986) and (Luc and Gavaille, 1987). See (Grew and Harrigan, 1986) for a reply and (Furet and Sachs, 1974) for a use of these data.

¹⁷²See in Table 3.A1 the Appendix.

¹⁷³Data on the height, collected at the level of districts for the 1818-1830 time period on 489 160 twenty years old conscripts (that is to say on men born between 1798 and 1810) is presented and analysed in (Aron et al., 1972). In 1804, Napoléon instituted a random draw to select the conscripts. Therefore, there is no selection bias with these data as each young man had the same probability to serve. The average height was clearly mirroring the economic development of France. This is in line with other studies exhibiting strong correlations between height, living and health conditions, work at young ages, nutritional intake, ... during the 17th and 18th centuries (Komlos et al., 2003), the 19th century (Villermé, 1829), at the end of this former and during the following (Chamla, 1964), (Meerten, 1990), (Brinkman et al., 1988). See (Steckel, 1995) for a review of the literature on this point.

¹⁷⁴The financial situation of municipalities of France and Algeria.

¹⁷⁵I selected these years and not 1878 and 1913 for example because they were also census years. I thought that the quality of the data could be improved by this.

check if the results obtained are not linked to a particular year. Second, I am able to study the persistence of the effect of education on resources. Lastly, knowing the timing when education potentially influenced development is useful in specifying the transmission channels between the two phenomena. Data from the industrial survey of 1839-1847 are the other economic data used in order to control for industrial production in the estimations¹⁷⁶.

The nineteenth century was a time of index-based taxation for the state and the municipalities. This system, implemented during the revolutionary period, remained remarkably stable all along the century and no major modifications were implemented to it before the creation of the income tax in 1914. The *Assemblée Constituante* implemented in 1791 a land tax, a personal property tax on incomes coming from other sources than land and commercial activities and a *patente* tax on these commercial resources. An additional tax on the number of doors and windows of habitations was later implemented in 1798. These four taxes, known as the *Quatre vieilles*, constituted the direct "contributions", as they were called, entering the state and municipalities budgets.

The land tax was based on net incomes coming from the use of lands¹⁷⁷, which were evaluated on the 15 preceding years¹⁷⁸. The personal property tax was composed of two distinct elements: the taxpayer had first to pay an amount equal to the average value of three workdays. This amount was fixed in each department. The second part of the tax was based on the rental value of personal residential buildings. The basis of the *patente* tax was incomes coming from trade and industry. However, it is only by means of rental value that these resources were taxed. The *patente* amounted to a percentage between 10 and 15% of the rental value of buildings. In industry, additional component depended directly on the number of workers and engines used in the production process (Chanut et al., 2000). Bakers had the privilege to pay half the tariff while beverage merchants had to pay the double. Since any trading activity was taxed by the *patente*, it reflects perfectly the commercial and industrial activity of the municipalities. The tax on doors and windows was positively related to their number and size. After 1832, the amount was higher in more populous municipalities. Also, the *patente* was the only flat tax of the four, the other three were "impôt de répartition", which means that the amount expected to be drawn from them was decided first by the state, and then divided between municipalities according to their estimated economic resources (Neurrisse, 1996).

Municipalities could also decide to increase what they were perceiving from these taxes by collecting "additional cents" on them. This was done by increasing the rate of the taxes. For example, collecting 3 additional cents was equivalent to ask taxpayers to pay 3 cents more for each franc of tax, which amounted to an increase of 3% in the rate. This was usually implemented to built or maintain byroads or in case of deficit. Additional taxes as the one on dogs implemented in 1855, on private pool tables (1871) or velocipede (1893) were also entering

¹⁷⁶More information on this survey can be found in (Chanut et al., 2000).

¹⁷⁷It is only in 1881 that a distinction between built-up and non-built-up property was introduced. Built-up property was from then on taxed according to its rental value.

¹⁷⁸The two best and worst years were excluded from the computation. See for example (Kang, 1993) on this tax.

the municipalities' budget but they were marginal compared to the four direct taxes described. Municipalities could also make use of resources coming from the *octrois*, which corresponded to indirect taxes on products imported and sold within the delimitations of the municipality¹⁷⁹. However, only the biggest municipalities were concerned by these indirect taxes. 1 538 of them were raising *octrois* in 1881, 1 523 in 1911¹⁸⁰.

The crucial point here is to know exactly what dimension of economic resources these tax data refer to. Is it to the resources of people or of places ? Since the taxes are mainly direct for the vast majority of municipalities, their amount should greatly reflect the resources or people. In this sense, the effect of education on taxes can be partly seen as being close to returns to schooling. However, many taxpayers were owning properties in a different municipality from the one they were living in. The same thing could also be said about the *patente*. To a lesser extent, manufacturers could live in a different municipality from where their industry was located. Moreover, there is no way to control for the migration of people over the 47 years separating the measure of education from the first on taxes. Therefore, this paper is closer to urban economic studies evaluating the impact of education on the growth of cities. The main difference is that these studies often focus on big towns, while around 90% of the municipalities in my sample are less than 2 000 inhabitants. Moreover, they often choose population growth as the outcome of interest while I focus here on the economic resources of municipalities. I therefore rather measure the impact of education on the economic growth of local places.

3.3 Demographical Data on Municipalities

Data on the population of municipalities from the censuses is taken from (Motte et al., 2003). Population dispersion is taken from the Postal Survey of 1847 along with the surface area of municipalities which have disappeared or merged since 1833¹⁸¹. Since this survey is posterior to the Guizot one, I have to assume that population remained stable over the fourteen years separating them, which seems to be a quite reasonable assumption. The *Institut national de l'information géographique et forestière*, a public organism in charge of the diffusion of geographic information in France, provides surface data for the other municipalities. The altitude of municipalities is also taken from this organism.

3.4 Descriptive Statistics

Descriptive statistics are displayed in Table 3.1. Primary schools were located in 59% of the municipalities in the data. Around 47% of the municipalities were subsidising primary schooling.

¹⁷⁹These *octrois* had been suppressed in 1791 and progressively reintroduced from 1798 onwards. Taxes on beverages were for example re-established in 1804, in 1806 for those on salt.

¹⁸⁰They could constitute a crucial source of income for big municipalities. For example, in 1913, half of the resources of Paris were coming from these indirect taxes. The budget of the state was also critically depending on indirect taxes. Registration duties, customs duties and taxes on sales of beverages and transports were constituting half of its budget in the 1830s, 53% in 1913. Direct taxes followed the opposite trend, from 30% to 10% of the budget between the same dates.

¹⁸¹More information on this survey is available in (Marin and Marraud, 2011).

Pupils spent on average 5 years at school, were learning on average around 5 different subjects and the number of pupils per 100 inhabitants was around 10 in municipalities with primary schools. The average taxes per capita nearly doubled between 1881 and 1911, from 7.5 to 13.3 francs¹⁸². This increase may partly reflect economic growth. It is also due to the fact that, after 1905 and the passing of the law separating churches and state, resources saved from the suppression of worship budget were split between municipalities according to their contribution to land tax on non-built property.

The average population of the municipalities was around 990 inhabitants in 1833, but 50% of them were less than 631 inhabitants and 90% less than 2 000. Population dispersion could be high within municipalities as the average scattering was around 47%, with a median value close to 50%. Information on printing presses refer to the instruments used in the instrumental variable estimations. More precision are provided on this point in Section 5.

Table 3.1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Primary School - 1833	0.59		0	1	8129
Public school - 1833	0.47		0	1	8129
Pupils per 100 inhabitants - 1833	9.5	6.8	0.3	61.6	4658
Schooling years - 1833	5.3	1.9	1	9	4629
Number of subjects - 1833	4.6	1.5	1	11	4139
Municipal income, francs per capita - 1881	7.5	10.3	0.4	469.4	7295
Municipal income, francs per capita - 1911	13.3	10.1	0.3	305.9	7302
Population - 1833	989.8	1811.9	30	75895	8064
Percentage of population scattered	46.8	35.6	0	100	6941
Population growth - 1793-1836	30.1	58.2	-88.4	1500	7931
Surface area - hectares	1725.5	1439.1	8	18359	7844
Average altitude - meters	207.7	194.6	1	1399	7844
Industrial production - 1839, francs per year	71.5	1167.9	0	59138	8129
Postal taxes - 1847, cents of francs	114.5	428.6	0	27894	8129
Distance to post office - kms	7.1	4.6	0	116	7302
Distance to prefecture - kms	36.2	16.9	0	128.3	7844
Distance to printing press - kms	61.1	38.4	0	256.3	7273
Printing presses within 75kms	1.3	1.1	0	5	7273
Printing presses within 100kms	2.2	1.5	0	9	7273
Printing presses within 150kms	5.2	2.8	0	13	7273

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*. (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: All variables are defined at the municipal level. The postal taxes correspond to the amount of taxes collected on postal activity within the two-week period when the postal survey was conducted.

¹⁸²Figure 3.B1 and Figure 3.B2 in the Appendix display the distribution of enrolment, schooling years and taxes per capita.

4 A Regression Discontinuity Design Based on the Guizot Law

Descriptively speaking, the level of taxes per capita was positively correlated with enrolment rates and schooling years. In Figure 3.2, I display this relation for years 1881 and 1911¹⁸³. These two measures can be taken as good proxies for human capital accumulation at the beginning of the nineteenth century in France. Indeed, since learning and teaching were thought in a more linear way than today, subjects like reading, writing, the arithmetic, ... were learnt one after another within primary schools (Furet and Ozouf, 1977b). Therefore, higher average schooling years were very likely to be synonymous with more subjects learnt and with a higher mastering of these subjects (Montalbo, 2019b). This proxy for intensive human capital accumulation is complemented by enrolment rates working as a proxy for the extensive accumulation.

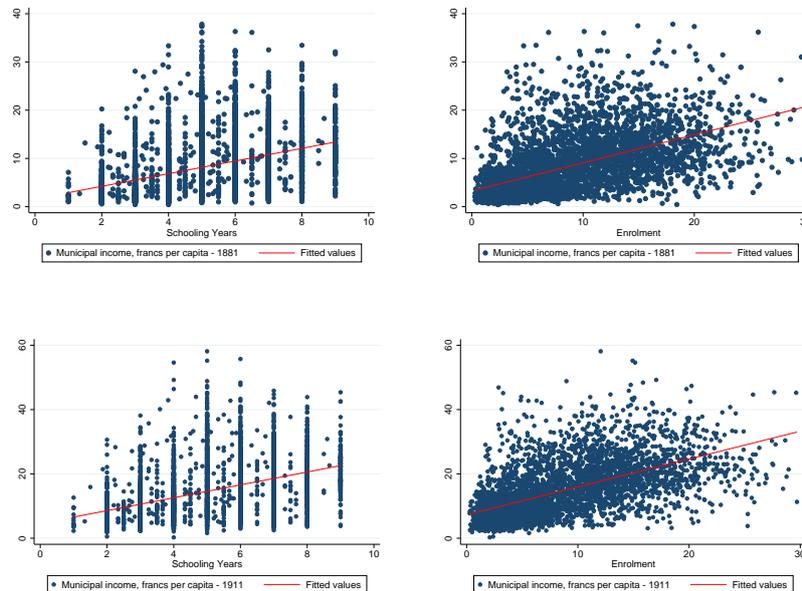


Figure 3.2: Scatterplots of income, enrolment and schooling years

Source: Guizot survey and *La Situation Financière des Communes*.

Since the measure of economic resources is posterior to the one of schooling, there is no reverse causality issue here. However, one might fear that wealthy municipalities would invest more in education at the beginning of the century, these very municipalities being also characterised by high amount of resources later on. In this case, the effect of schooling would be badly estimated with simple OLS. In this section, I take advantage of the fact that the Guizot Law made mandatory for municipalities more than 500 inhabitants to open and finance a primary

¹⁸³When more than one school was present in a municipality, I computed schooling years as the mean between the average value within each school.

school after 1833. Thanks to the Guizot survey, I can know which municipalities had no school at that time. I therefore selected them and apply a regression discontinuity around the threshold of 500 inhabitants¹⁸⁴.

This strategy bears some drawbacks as I cannot know if municipalities below the threshold opened or not a school just after 1833. However, as they were very small and had not done so before, there is only a very little probability that a high number of municipalities just below the threshold would do so just after the law while they had no legal obligation to open a school. Therefore, these municipalities were certainly characterised by a long-lasting absence of primary school during the nineteenth-century. If some of them did open a school anyway, the following estimations would return a lower bound for the impact of primary schooling on economic development. Finally, I cannot measure the effect of enrolment rates or schooling years using this strategy. I will therefore only be able to evaluate the impact of a primary school's presence. However, monographic studies report that the positive supply shock on education caused by the Guizot Law contributed to increase significantly enrolment rates (Thabault, 1993), (Blanc and Wacziarg, 2018). Therefore, the presence of a primary school after the law was passed was very likely to be associated with a higher human capital accumulation in the municipality at stake.

In Figure 3.3, I plot the data-driven regression discontinuity in municipal resources according to the difference between municipal population and the 500-inhabitant threshold in 1881 and 1911.

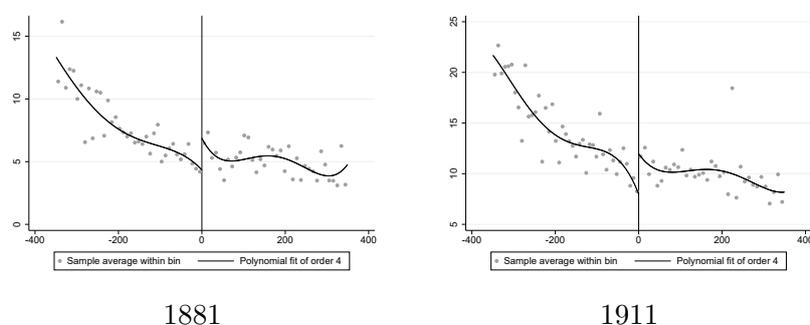


Figure 3.3: Data-driven regression discontinuity in municipal resources per capita

Source: Guizot survey and *La Situation Financière des Communes*.

Notes: On the x-axis, the distance in terms of population to the 500-inhabitant threshold is displayed. The polynomial fit used is of order four. The number of bins has been selected through the mimicking variance evenly-spaced method using spacings estimators. For the 1881 year, 38 bins are selected left to the threshold, with an average length of 9 inhabitants. 36 bins are selected right to the threshold, with an average length of 9.7 inhabitants. The respective figures for 1911 are of 43 and 35 bins, with average lengths of 8 and 10 inhabitants.

The resources per capita were decreasing in population between 100 and 500 inhabitants. Very small municipalities had therefore on average higher economic resources per capita than municipalities around the 500 inhabitant threshold. There is a jump in resources around this

¹⁸⁴See (Lee and Lemieux, 2010) for a literature review of regression discontinuity designs in economics.

threshold, which become much more stagnant afterwards. This indicates a discontinuity in resources related to the presence of a primary school¹⁸⁵.

As recommended in (Imbens and Lemieux, 2008) or (Lee and Lemieux, 2010), one should check several conditions in order to account for the reliability of the regression discontinuity approach. The first one is the continuity of the running variable density (here population) around the threshold. If this variable can be completely manipulated by the units in order to obtain or avoid a given treatment, then the regression discontinuity will be biased. If the manipulation is only partial, the estimations will remain valid (McCrary, 2008). In this case, a complete manipulation would arise if, knowing the 500 inhabitant threshold of the Guizot Law and anticipating its passing, municipalities around this threshold tried to artificially lower their population level in order to avoid having to open and fund a primary school. This seems to be unlikely. This idea is reinforced by a graphical analysis exhibiting no discontinuity of population density around the threshold¹⁸⁶. A manipulation test, implemented following (Cattaneo et al., 2018), returns a p-value of 0.6591, confirming the fact that municipalities didn't manipulate the forcing variable around the threshold.

Therefore, I turn to the estimations following the non-parametric model :

$$Y = \alpha + \tau D + \beta_1(X - c) + \beta_2 D(X - c) + \varepsilon \quad (4)$$

where Y is my variable of interest, namely taxes per capita in 1881 and 1911, and X the population level. Let c be the treatment cut-off and D a binary variable equal to one if $X \geq c$. Let h being the bandwidth of data used, then it follows that $c - h \leq X \leq c + h$. In this model, different slopes and intercepts fit data on either side of the cut-off. In Table 3.2, I report the estimation outcomes using a flexible linear and quadratic specification and using different population bandwidth, from 50 to 150 inhabitants. I report also a bandwidth of 105.9 for the year 1881 and 90.3 for 1911, selected as optimal bandwidths using the *rdbwselect* command in *Stata* (Calonico et al., 2017).

Results show a positive impact of education on the economic development of municipalities, with a magnitude between 1.5 and 3 francs per capita depending on the bandwidth selected. As expected, the magnitude is higher closer to the threshold. Primary education contributed therefore to increase the economic resources of municipalities during the nineteenth century and until World War I.

¹⁸⁵See Figure 3.B3 for discontinuities computed using different polynomial orders.

¹⁸⁶See Figure 3.B4 in the Appendix.

Table 3.2: Non-parametric regression discontinuity estimates - Municipal resources per capita, 1881 and 1911

	Flexible linear					Flexible quadratic				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RD Estimate - 1881	3.002*** (3.034)	2.295*** (2.745)	1.302* (1.751)	1.159* (1.745)	1.320** (2.243)	3.180** (2.126)	3.237*** (2.641)	2.989*** (2.693)	2.470** (2.536)	1.739* (1.932)
Observations	347	500	694	804	957	347	500	694	804	957
Population bandwidth	50	75	105.9	125	150	50	75	105.9	125	150
RD Estimate - 1911	4.039*** (3.190)	2.927*** (2.740)	2.495** (2.473)	1.744** (2.020)	1.549** (2.013)	4.711** (2.448)	4.943*** (3.187)	4.179*** (2.857)	3.804*** (2.959)	3.044** (2.528)
Observations	350	503	599	806	961	350	503	599	806	961
Population bandwidth	50	75	90.3	125	150	50	75	90.3	125	150
Covariates	No	No	No	No	No	No	No	No	No	No

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: I report the estimation outcomes using a flexible linear and quadratic specification and using different population bandwidth, from 50 to 150 inhabitants. I report also a bandwidth of 105.9 for the year 1881 and 90.3 for 1911, selected as optimal bandwidths using the *rdwselect* command in *Stata* (Calonico et al., 2017).

The effect is therefore robust to the choice of different population bandwidth. In Table 3.3, I run the same kind of model using a kernel estimation with the *rdrobust* command (Calonico et al., 2017) and the optimal bandwidth selection associated to it¹⁸⁷. The difference between columns (1), (5) and (2), (6) is that I include covariates in the last two¹⁸⁸. In columns (3) and (7), I add covariates which are also incorporated in the computation of the optimal bandwidth, which is not the case in columns (2) and (6). Finally, I cluster standard errors at the district level in columns (4) and (8). All the specifications return positive and significant outcomes, with a magnitude of around 2 francs per capita. This is close to one-third of a standard deviation in economic resources¹⁸⁹. The impact of primary schools' presence is therefore also robust to the inclusion of covariates, the choice of a kernel estimation and the use of clustered standard errors¹⁹⁰.

These results remain consistent with the estimation of several robustness checks. The use

¹⁸⁷See for example (Imbens and Kalyanaraman, 2012) on the optimal bandwidth selection.

¹⁸⁸These covariates are the same ones that I will use in the instrumental variable estimations, namely : population dispersion (taken as the share of the total population that didn't match the contiguity criterion. See (Roncayolo, 1987) on this point), surface area, altitude, population growth 1793-1836, postal taxes, the distance to the post office and to the prefecture, latitude, and a dummy variable indicating if the municipality at stake is in a department with a printing press.

¹⁸⁹See Figure 3.B5 in the Appendix for a graphical representation of the effect estimated.

¹⁹⁰As specified in (Lee and Lemieux, 2010), the inclusion of covariates should not lead to a different outcomes in a regression discontinuity design. Indeed, if the setting is good and therefore close to a randomised experiment, then the assignment to treatment is, by construction, independent of the baseline covariates. However, the adding of covariates reduces the sampling variability in the estimator. A substantive precision was gained as confidence intervals shrank by around 10% with the inclusion of covariates from column (1) to (3). This is in line with the recent work of (Calonico et al., 2019).

of a coverage error rate (CER)-optimal bandwidth instead of a mean square error (MSE)-optimal one doesn't modify greatly the outcomes. The is also true for the manual selection of various bandwidths (the same as in Table 3.2) under the same kernel estimation¹⁹¹. Finally, two important things remain to check when working with regression discontinuities. First one needs to investigate the continuity of covariates around the threshold. Second, it is necessary to run falsification tests in order to show that there is no other discontinuities having an impact on the variable of interest. Indeed, a discontinuity in covariates would cast doubt on the comparability between municipalities above and below the threshold. Also, the existence of unexplained discontinuities around different population cut-offs would weaken the reliability of the estimation. Outcomes of Table 3.A4 and Table 3.A5 in the Appendix reject these two issues. This reinforces the strength of the regression discontinuity design used and the reliability of the impact of education on the economic development of municipalities¹⁹².

Table 3.3: Non-parametric regression discontinuity estimates - Municipal resources per capita

	1881				1911			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD Estimate	2.009*** (2.63)	1.856*** (3.14)	2.417*** (3.45)	2.254*** (3.00)	3.166*** (3.00)	2.211*** (2.62)	1.815** (2.41)	1.698* (1.86)
Controls	400	333	222	261	339	285	366	388
Treated Units	294	245	182	208	260	212	264	284
Covariates	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Left Clusters				67				72
Right Clusters				62				66
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
Order Loc. Poly.	1	1	1	1	1	1	1	1
Order Bias	2	2	2	2	2	2	2	2
BW Loc. Poly.	105.9	105.9	73.21	84.40	90.31	90.31	116.7	126.1
BW Bias	188.5	188.5	142.4	148.1	170.3	170.3	218.5	219.4

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: In columns (3) and (7), I add covariates which are incorporated in the computation of the optimal bandwidth. This is not the case in columns (2) and (6) where the covariates are added without entering in the computation of the optimal bandwidth. I cluster standard errors at the district level in columns (4) and (8).

¹⁹¹See Table 3.A2 and Table 3.A3 in the Appendix.

¹⁹²For the falsification tests, I don't estimate them on population cut-offs superior to 2 000 inhabitants since this would highly restrict the number of observations. There is for example only 49 municipalities in the data between 1 900 and 2 100 inhabitants without schools.

5 Printing Press as an Instrumental Variable

5.1 Printing Press and Primary Education

The use of an instrumental variable (IV) technique will enable me to evaluate the effect of schooling years and enrolment rates on the economic development of municipalities. I will also be able to assess this effect on all municipalities and not only small ones concentrated around the 500-inhabitant threshold. The idea is to use the distance of municipalities to the nearest printing press established before 1500 along with the number of printing presses within a given radius as instruments for primary schooling.

Indeed, education seems to have developed close to the location of the first printing presses in France. This is especially true for the north-eastern part of the country located near Mainz, the town where the first printing press was established by Gutenberg around 1450. The distance to this city has already been used as an instrument for primary education (Diebolt et al., 2017b). The main idea behind the use of these instruments is that printing presses favoured the dissemination of written culture, the presence of teachers, scholars and administrative activities which required higher educational achievements. During the second half of the 15th century, printing presses were mainly established in ecclesiastical and student cities. Indeed, most of the printing industry's outlets were located there. A high concentration of legal professionals and rich merchants was also attracting printers. Paris, Lyon and Venice rapidly became the most active printing places in Europe. 45% of the books printed before 1500, the incunabula, were related to religion, 30% to medieval literature, more than 10% related to legal matters and around 10% to scientific subjects (Febvre and Martin, 1999). The printing press didn't really enhance the diffusion of new scientific ideas, but it helped spreading the access to classical authors as Aesop, Cato and Seneca, or later to humanist writers like Erasmus.

The printing press has long been considered as a key determinant in the diffusion of literacy during the Renaissance period in Europe (Grendler, 1990). This effect, which can only have been very gradual (Eisenstein, 1980), still lacks evidence. However, it has been recently identified in the case of Sub-Saharan countries (Cagé and Rueda, 2016). The important questions here are twofold. First, what are the reasons why the printing press would have influenced the diffusion of education in small municipalities around the towns where it was established? And second, if this effect is true, was it really strong enough so that printing presses could be used to instrument primary education in 1833?

It is true that the diffusion of books in the hands of religious people, lawyers or students is likely to have been concentrated within big towns. However, the higher dissemination of written culture may have reached even the small municipalities around these towns through several channels. Firstly, the increase in literacy and education in big towns is very likely to have positively influenced the concentration of teachers. These teachers may then have looked for smaller municipalities where the competition between them was low to settle in. This effect was certainly very gradual.

A more direct effect was due to the activity of peddlers who were travelling from municipality to municipality to sell books. Knighthood novels were in particular extremely popular during the 15th and 16th centuries and likely to be sold by peddlers¹⁹³. The increasing number of books written in vernacular language and not Latin, already 22% in the 15th century, also favoured this diffusion (Febvre and Martin, 1999)¹⁹⁴. Peddlers' activity is very likely to have been concentrated around towns with printing presses because of the higher transaction costs associated with high travelling distances. Even if only a few people could afford to buy books at that time and even in the 19th century, their presence in a given municipality may have positively influenced the culture of the whole village (Eisenstein, 1968). Moreover, before the 19th-century mass movements of education, literacy was often taught to children in small municipalities by parents, neighbours, or by the only literate person living in the village (Laqueur, 1976). Parish priests also often assumed this task in rural France. Therefore, if the printing press contributed to increase even by a small amount the share of people able to deliver this kind of teaching, this has certainly influenced people's taste for education and the diffusion of literacy.

Another very important transmission channels is constituted by the influence of printed sheets describing local celebrations, the conduct of a battle, ... and which were stuck on a wall in plain sight within municipalities. The printing press contributed to increase their number and their diffusion (Febvre and Martin, 1999). Once again, this phenomenon is very likely to have taken place, or to have been more intense, in the municipalities close to the printing press. The dissemination and multiplication of these sheets increased the contacts between the inhabitants and written culture. This certainly increased the incentives to master literacy in the municipalities at stake. The diffusion of Protestantism has also been linked to the printing press. However, in the case of France, it is hard to assert that printing presses particularly helped its diffusion. This effect seems to have been stronger in Germany.

In order to evaluate the association between the printing press and primary schooling, I use the same data sources as in (Dittmar, 2011), the *Incunabula Short Title Catalogue* (ISTC, 1998) maintained by the British Library and *L'Apparition du livre* by Febvre and Martin (Febvre and Martin, 1999). I select the 39 French cities where a printing press was established in 1500 and some Belgian, Swiss, German, Dutch, Italian and Spanish cities that could fall within the radii selected around municipalities. The 80 cities present in the database are depicted in Figure 3.4. Descriptively, there is a positive correlation between the distance to the nearest printing press, the number of printing presses within 100 kms, schooling years and enrolment rates. I depict this relation in Figure 3.5, dividing the scatterplots on enrolment by population bounds to ensure a higher homogeneity of the age structure between municipalities. On average, pupils were more numerous and stayed at school during a higher number of years when located closer to printing presses. I keep municipalities without schools in the analysis. The log of enrolment

¹⁹³Books like the *Quatre fils Aymon* or *Fierabras* knew a large diffusion at that time.

¹⁹⁴The use of vernacular language has been intensively promoted under the reigns of Louis XII (1498-1515) and François Ier (1515-1547) in France. This phenomenon therefore followed very closely the introduction of the printing press.

is therefore computed as $\ln(1 + enrolment)$ in order to take into account the zero-value rate. I take a 100kms radius since a lower one would reduce too highly the number of printing presses around municipalities. Indeed, with a 75kms radius, this number would only vary between zero and five. A higher threshold would lower the precision of the association with education. Indeed, printing presses located far away from the municipalities at stake are less likely to have influenced significantly primary schooling.



Figure 3.4: Location of printing presses in 1500

Source: (ISTC, 1998) and (Febvre and Martin, 1999).

Note: Departments in blue are the ones for which education data are available at the level of municipalities.

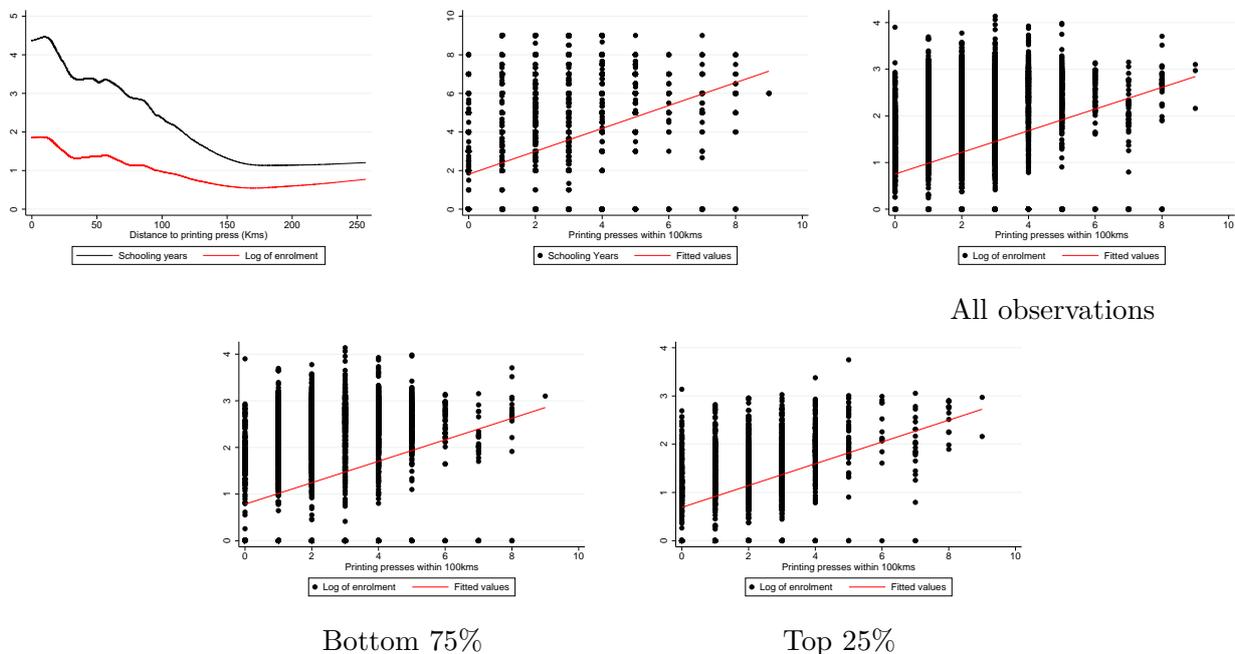


Figure 3.5: Distance to the printing press, printing presses within 100kms, schooling years and enrolment. Locally weighted scatterplot smoothing and scatterplots.

Source: Guizot survey, (ISTC, 1998) and (Febvre and Martin, 1999).

Note: A bandwidth of 0.25 is applied for the locally weighted scatterplot smoothing. Scatterplots on enrolment rates are divided by population bounds.

This is confirmed by the estimation of the following first stage :

$$Educ_m = \alpha + \beta_1 Instr_m + \beta_2 Demo_m + \beta_3 Eco_m + \epsilon_{m,arr} \quad (5)$$

where $Educ_m$ represents schooling years or enrolment rates measured within the municipality m . $Instr$ is the instrument used, namely the distance to the nearest printing press or the number of printing presses within 100 kms. $Demo$ stands for the demographic and geographic characteristics of municipalities and Eco for variables related to their potential economic resources. Standard errors indexed by arr are clustered at the district level. This is done in order to account for spatial correlation either when using OLS (Moulton, 1986), (Moulton, 1990) or using IV estimations (Shore-Sheppard, 1996), (Hoxby and Paserman, 1998). Indeed, the education residual is likely to be correlated at the department and district levels.

For what regards demographic and geographic variables, I control by the average altitude of municipalities, their surface area, their latitude, their total population in 1833 and by the share of their population that is considered to have been scattered. Mountainous land is expected to have been a potential barrier to economic development, as well as the population dispersion. Indeed, a high dispersion was implying longer travel times and a less accessible workforce. Population should on the contrary be positively correlated with economic development. Latitude is expected to control for potential temperature and soil quality differences between municipalities. The economic controls are population growth between 1793 and 1836, the distance to post office, the amount of postal taxes collected in municipalities, the level of industrial production and the distance to the prefecture. Postal activity was clearly reflecting economic dynamism in the mid-19th century since most of the letters were sent by businessmen (Chartier et al., 1991), (Richez, 2002)¹⁹⁵. I also add a department dummy variable indicating if municipalities were located in a department with a printing press in 1500.

Distance to the printing press and the number of such presses within 100 kms appear to have been significantly linked to the presence of primary schools, schooling years and enrolment rates. The outcomes of Table 3.4 indicate that increasing this distance by one kilometre was reducing the probability to find a primary school in the municipality at stake by 0.3%. This was also implying a reduction of 0.02 schooling years, of 0.8% in enrolment rate for municipality less than 1 109 inhabitants (bottom 75%) and of 0.4% in municipalities above this threshold. One more printing press within 100kms was associated with the respective increases of 8.5% for the primary school probability, 0.6 schooling years and around 20% in enrolment.

¹⁹⁵These variables are also expected to have influenced primary schooling. Population dispersion is likely to have impacted negatively primary schooling by increasing the distance from habitations to schools and therefore decreasing the number of pupils (Furet and Ozouf, 1977b). Mountainous land is expected to have had the same effect. Population should, on the contrary, have increased the potential number of pupils and the resources municipalities could dedicate to education. Economic controls are likely to have been positively related to primary schooling.

Table 3.4: OLS estimations - Primary schooling and printing presses

	Primary school		Schooling years		Log of enrolment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Population intervals:						Bottom 75%	Top 25%	
Distance to printing press (kms)	-0.003*** (-3.273)	–	-0.021*** (-4.408)	–	-0.008*** (-3.594)	–	-0.004** (-2.603)	–
Printing presses within 100kms	–	0.085*** (3.970)	–	0.589*** (4.223)	–	0.223*** (3.442)	–	0.193*** (6.328)
Population dispersion	-0.004*** (-6.782)	-0.005*** (-7.820)	-0.030*** (-6.650)	-0.032*** (-7.556)	-0.012*** (-6.777)	-0.013*** (-8.027)	-0.013*** (-8.378)	-0.012*** (-9.015)
Population	0.0001*** (4.765)	0.0001*** (4.621)	0.001*** (2.987)	0.0001** (2.558)	0.001*** (3.594)	0.000*** (2.955)	-0.000 (-1.051)	-0.000 (-0.976)
Surface area	-0.000 (-1.378)	-0.000 (-0.356)	-0.002** (-2.012)	-0.001 (-0.893)	-0.002*** (-3.005)	-0.001* (-1.814)	-0.001*** (-3.783)	-0.0005** (-2.601)
Altitude	-0.000 (-1.373)	-0.0002* (-1.840)	-0.000 (-0.128)	-0.000 (-0.582)	-0.000 (-0.598)	-0.000 (-1.056)	0.000 (0.899)	0.000 (0.269)
Population growth - 1793-1836	-0.000 (-0.487)	-0.000 (-0.962)	0.000 (0.152)	-0.000 (-0.418)	0.000 (0.120)	-0.000 (-0.068)	-0.000 (-0.653)	-0.001 (-1.630)
Distance to post office	-0.003 (-1.442)	-0.003 (-1.422)	-0.016 (-1.244)	-0.016 (-1.242)	-0.003 (-0.441)	-0.002 (-0.398)	-0.004 (-0.889)	-0.004 (-0.886)
Postal taxes	-0.000 (-0.983)	-0.000 (-0.856)	-0.000 (-1.364)	-0.000 (-1.220)	0.000 (0.534)	0.000 (0.691)	0.000 (1.126)	0.000 (1.182)
Industrial production	0.0001* (1.860)	0.0001** (2.208)	0.0005** (2.055)	0.001** (2.395)	0.000 (0.595)	0.000 (0.550)	0.000 (0.821)	0.000 (1.443)
Distance to prefecture	0.000 (0.288)	-0.001 (-0.595)	0.002 (0.257)	-0.006 (-0.698)	-0.001 (-0.293)	-0.004 (-1.156)	0.003 (1.466)	0.001 (0.504)
Latitude	-0.005 (-0.324)	-0.018 (-1.111)	0.257** (2.374)	0.164 (1.474)	0.119*** (2.883)	0.084* (1.937)	0.029 (0.888)	0.005 (0.161)
Dep. with printing press	-0.171** (-2.169)	-0.198** (-2.454)	-1.150** (-2.239)	-1.249** (-2.377)	-0.518** (-2.437)	-0.557** (-2.396)	-0.076 (-0.457)	-0.204 (-1.470)
Observations	6081	6081	5939	5939	4769	4769	1227	1227
R^2	0.154	0.176	0.255	0.275	0.272	0.290	0.373	0.416
Clusters	91	91	91	91	89	89	86	86

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003), (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: *Primary school* is a dummy variable taking value one if a school was located in the municipality at stake. Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

In order to reinforce the idea of a link between the printing press and primary schooling, I also made use of the first literacy measure available for France in 1686-1690. Literacy is computed as the percentage of people being able to sign their marriage contract and is available at the level of departments. Figure 3.B6 in the Appendix depicts the spatial distribution of literacy rates. It is very close to the one in 1833 represented in Figure 3.1. The spatial inequalities in education achievements remained indeed very stable in France between the 17th century and the mid-19th century (Lebrun et al., 2003). Table 3.A6 in the Appendix shows that the number of printing presses in 1500 was positively related to both the literacy level of men and women

in 1686-1690¹⁹⁶, with a magnitude of around 1% for women and 1.7% for men. Therefore, the printing press was early associated with primary schooling and, due to the absence of other factors enhancing an education convergence between departments, its effect remained significant even at the beginning of the 19th century.

5.2 Printing Press and Economic Development

A problem with these instruments could arise if the presence of printing presses or their concentration within a given radius is correlated with the economic development of municipalities before the nineteenth century. If richer municipalities were establishing printing presses and developing primary education at the same time, then these presses would only reflect the higher economic resources of the municipalities at stake. According to (Dittmar, 2011), the presence of a printing press contributed to the population growth of cities between 1500 and 1800, thanks to its effect on "the acquisition and development of skills that were valuable to merchants and businessmen". Therefore, at first sight, these instruments may seem to be invalid. However, the study of Dittmar focuses only on the cities where the printing press was established. This amounts to 39 towns for France. Moreover, the data from (Bairoch et al., 1988) indicates that these cities were highly populated, around 18 000 inhabitants on average, which clearly makes them particular cases compared to the "average municipality" at that time. Even in 1793, only 5% of all municipalities in France were more than 1 900 inhabitants, only 0.17% more than 18 000 inhabitants.

The crucial assumption that I make at this stage is that, even if the printing press contributed to the growth of cities in France, they didn't influence significantly the economic development of smaller municipalities, even when they were located close to them. This assumption is in compliance with the effects of the printing press on economic growth which were identified to have been very localised within big towns (Dittmar, 2011). Moreover, printing presses had a positive effect of the population growth of towns. If part of this effect went through an increase in migrations coming from nearby municipalities, this would have thwarted the potential positive effect of the press on these very municipalities. I computed several robustness checks on the IV estimations, excluding municipalities close to the cities with a printing press. This didn't modify the outcomes, which reinforces the idea that the instrument is not associated with a positive income effect of printing presses on growth.

One could still be afraid that municipalities with a printing press would drive the outcomes or break the exclusion restriction. Ten municipalities in my database had a printing press in 1500¹⁹⁷. However, they are excluded from the IV estimations. Indeed, I include postal controls to check for municipal economic dynamism. One specificity of the postal survey is that it was implemented mainly on small municipalities. Big towns more than 10 000 inhabitants for

¹⁹⁶I compute this number within 150kms around the administrative centre of each department. I am forced to increase the distance in these estimations since, for many departments, only a very small amount of printing presses was located within lower radii.

¹⁹⁷These municipalities are: Anduze, Tours, Nantes, Orléans, Châlons-en-Champagne, Haguenau, Strasbourg, Provins, Mâcon and Avignon.

example were excluded from the survey¹⁹⁸. As this was the case for seven towns over the ten with the printing press, I excluded also the other three from the analysis. Adding them to the estimations by letting aside postal controls doesn't modify the outcomes¹⁹⁹.

In Table 3.5, I provide a first indication that the exclusion restriction is very likely to hold. In columns (1) to (4), I take population data from (Bairoch et al., 1988) in order to evaluate if the presence of a printing press in a given town influenced positively its population and economic growth²⁰⁰. I find no significant impact of this presence, either between 1700 and 1750 or between 1700 and 1800. Therefore, the growth of large cities during the 18th century was actually not significantly influenced by the printing press in France. This outcome indicates that small municipalities around cities are not likely to have benefited from economic spillovers caused by the printing press.

In columns (5) to (8), I evaluate its impact on the population of the municipalities in my database, 40 years before my measure of primary schooling and nearly 90 years before my proxy for economic development. Again, I find no significant link between the printing press and population growth. Municipalities historically close to the printing press were therefore not growing significantly more than the others in the early 19th century. Also, I find no impact of the printing press on the level of industrial production within municipalities or on the amount of postal taxes collected in the mid-19th century²⁰¹. Municipalities close to the first presses were not significantly richer than their counterparts at the beginning of the period under scrutiny in this work. Therefore, there is no strong reason to think that the pre-19th century economic development of municipalities in my database was significantly influenced by the printing press.

¹⁹⁸On this point, see for example (Poublan, 1997-1998).

¹⁹⁹Results available upon request.

²⁰⁰On the use of population as a proxy for economic development, see for example (De Vries, 1984) and (Acemoglu et al., 2005).

²⁰¹See Table 3.A7 in the Appendix.

Table 3.5: Printing press instrument - Exclusion restriction using population levels

	Bairoch et al. population data				Municipalities from the Guizot survey			
	Pop. growth 1700-1750		Pop. growth 1700-1800		Population - 1793		Pop. growth 1793-1836	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Printing presses within 100kms	-0.253 (-0.165)	-	5.485 (1.245)	-	15.099 (0.554)	-	2.755 (1.210)	-
Distance to printing press (kms)	-	0.088 (1.145)	-	-0.221 (-0.936)	-	-0.066 (-0.038)	-	0.016 (0.370)
Surface area	0.000 (0.204)	0.000 (0.338)	-0.000 (-0.116)	-0.000 (-0.171)	4.757*** (8.083)	4.736*** (7.906)	-0.020*** (-2.634)	-0.025*** (-3.480)
Altitude	-0.012 (-0.841)	-0.010 (-0.776)	-0.023 (-0.584)	-0.014 (-0.358)	-0.862*** (-4.289)	-0.848*** (-4.095)	-0.003 (-0.261)	-0.000 (-0.002)
Latitude	0.531 (0.490)	0.822 (0.767)	-0.810 (-0.242)	-0.340 (-0.103)	-4.717 (-0.327)	-3.105 (-0.223)	-1.715 (-1.277)	-1.456 (-1.072)
Printing city	1.427 (0.232)	6.785 (0.892)	-8.128 (-0.419)	-14.383 (-0.611)	-	-	-	-
Dep. with printing press	-	-	-	-	26.959 (0.328)	50.874 (0.645)	-3.781 (-0.836)	1.966 (0.459)
Observations	141	141	163	163	7114	7114	7080	7080
R^2	0.010	0.020	0.011	0.006	0.148	0.148	0.008	0.005
Clusters					92	92	92	92

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: (Motte et al., 2003), postal survey, (ISTC, 1998), (Febvre and Martin, 1999) and (Bairoch et al., 1988).

Estimations at the level of departments complement this analysis. In Table 3.6, I find no significant link between the printing press and several development indicators, the urban population in 1700, the returns on cereal production in 1815, life expectancy and the 0-5 year mortality rate in 1806-1810. If the printing press had a positive influence on the development of a high share of municipalities, one would expect to find a positive correlation at the level of departments. Therefore, its influence seems to have been limited to, at best, the biggest towns of the country without influencing significantly the pre-19th century growth of the other municipalities.

Table 3.6: Printing press and department characteristics. OLS and Tobit estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tobit				Tobit			
	Urban population 1700	Returns on cereals 1815	Life expectancy 1806-1810	Mortality rate 0-5 years 1806-1810	Urban population 1700	Returns on cereals 1815	Life expectancy 1806-1810	Mortality rate 0-5 years 1806-1810
Printing presses within 150kms	-1.012 (-0.564)	0.199 (1.153)	-0.234 (-0.757)	0.002 (0.610)	-	-	-	-
Distance to printing press (kms)	-	-	-	-	-0.006 (-0.033)	-0.001 (-0.088)	-0.029 (-0.993)	0.0004 (1.063)
Surface area	-0.000 (-1.644)	-0.000 (-0.990)	-0.000*** (-2.888)	0.000*** (2.728)	-0.000 (-1.425)	-0.000 (-0.951)	-0.000** (-2.171)	0.000** (2.013)
Altitude	-0.070*** (-2.958)	-0.001 (-0.776)	-0.009*** (-2.915)	0.000*** (2.969)	-0.073*** (-3.099)	-0.001 (-0.466)	-0.009*** (-3.093)	0.000*** (3.108)
Dep. with printing press	23.579** (2.615)	0.228 (0.264)	2.091 (1.343)	-0.028 (-1.391)	21.937 (1.375)	0.351 (0.237)	-0.321 (-0.122)	0.004 (0.129)
Male literacy - 1686-1690	-	0.114*** (3.960)	0.155*** (2.976)	-0.002*** (-2.968)	-	0.124*** (4.419)	0.139*** (2.787)	-0.002*** (-2.824)
Observations	84	75	75	75	84	75	75	75
Left-censored observations	39				45			
Uncensored observations	45				39			
R^2		0.254	0.283	0.281		0.240	0.287	0.289
Pseudo- R^2	0.040				0.040			

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: *Statistique générale de la France*, IGN data, (ISTC, 1998) and (Febvre and Martin, 1999). Life expectancy and mortality rate from (Bonneuil, 1997). Urban population in 1700 is provided by (Lepetit, 1988). Returns on cereals are computed from the *Archives statistiques du Ministère des travaux publics de l'agriculture et du commerce*.

Notes: The unit of analysis is the department. The administrative centre of departments, the *préfecture*, was taken as the point from which distances were measured for each unit of analysis.

5.3 IV Outcomes

The second stage estimation equation is the following :

$$Dev_m = \alpha + \beta_1 Educ_m + \beta_2 Demo_m + \beta_3 Eco_m + \epsilon_{m,arr} \quad (6)$$

where Dev stands for the economic development of municipalities in 1881 or 1911 and where $Educ$ is instrumented by the printing press variables. In Table 3.7, I estimate the effect of primary education on the log of municipal resources in 1881 using both instruments. The Sanderson-Windmeijer F -stat is superior to ten in three cases over four, which tends to exclude the issue of weak instrument. This also prevents the estimations to be greatly biased if the printing press was even slightly directly correlated with economic resources (Bound et al., 1995). However, using both instruments performs moderately well when focusing on the impact of enrolment on municipalities less than 1 109 inhabitants (the bottom 75%). This is why I will also use each instrument separately. The Hansen J p-value is superior to 10% in each case, which gives more credit to the exogeneity of the instruments used.

Outcomes indicate that one more year of primary schooling in a given municipality was associated with a 18.2% increase in economic resources using the IV strategy, 5% using the simple OLS. A one-percent increase in enrolment was linked to an increase in resources of around 0.5% when focusing on municipalities less than 1 109 or 1 935 inhabitants (bottom 75% or 90%), 0.6% for the more populous ones. Again, OLS estimates are lower, with a magnitude around 0.14% and 0.28%. IV estimates correspond to an increase of around 0.22 francs per capita for a 10% increase in enrolment and of around 0.8 francs per capita for an additional schooling year.

In all estimations, the IV estimates are superior to the OLS ones. This is most likely due to the fact that there may be strong measurement errors in schooling years and enrolment rates which the IV estimations help to correct. Indeed, this information has been collected by inspectors within each primary school in a limited amount of time. This may have created approximations in the evaluation of primary schooling achievements²⁰².

Moreover, within primary schools located in small municipalities, pupils were often attending school quite erratically. It was common for example to see them one year in class and not the following. Indeed, their labour-force was often needed to ensure the financial stability of the family. Roughly speaking, only a small number of pupils were attending schools all year long and were not likely to be diverted from it by any other productive need, especially agricultural, that would require their participation (Furet and Ozouf, 1977b), (Mayeur, 2004). In bigger towns, enrolment was more likely to be stable as families had on average higher economic resources to be dedicated to primary education. Since most of the municipalities in France were relatively small in 1833, 90% less than 1 935 inhabitants in my database²⁰³, the issue of measurement error could have been indeed strong. Teachers or city mayors were more likely to make cruder approximations of schooling years and enrolment rates in these small municipalities where they were varying more, which explains why the IV estimates are above the OLS ones. The magnitude of the difference between the two is, as expected, higher in smaller municipalities when computing the effect of enrolment rates.

The number of printing presses within 100kms seems to be the most effective driver of primary schooling achievement. Indeed, in Table 3.7, one may see that the distance to the nearest printing press is not significant in the first stage for big towns. This can be easily understood since bigger cities were more likely to develop primary schooling, either located close or far from a town with a printing press. One printing press in the surrounding area was not likely to make a big difference. However, a higher number of printing presses could have favoured even more the extension of written culture and of primary schooling. This accounts for the positive association between the number of presses, enrolment and schooling years in 1833. Therefore, I only use this instrument in Table 3.8²⁰⁴. The magnitude of the outcomes between the two tables is very close. The instrument is now strong in all specifications, which reinforces the reliability of the IV estimates. I also add in this table a *regression based p-value*²⁰⁵, which is always inferior to 5%. The potential exogeneity of the primary schooling variables is therefore rejected. This argues for the use of IV estimations.

²⁰²Measurement errors have been evaluated to account for around 10% of the difference between OLS and IV estimates in the individual schooling/earning relation (Card, 1999). However, here, this difference is likely to be much higher due to the less precise information conveyed by historical data compared to contemporaneous ones.

²⁰³For the entire country, this level is around 1 637 inhabitants.

²⁰⁴Using only the distance to the nearest printing press actually leads to similar outcomes. However, the instrument remains weak for big towns. See Table 3.A8 in the Appendix.

²⁰⁵It relies on a test robust to clustering developed by Wooldridge.

Table 3.7: OLS and IV estimations - Schooling years, enrolment and municipal resources

Population intervals	Log of municipal resources, francs per capita - 1881							
			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.050*** (4.636)	0.182*** (3.269)	-	-	-	-	-	-
Log of enrolment	-	-	0.125*** (4.461)	0.460*** (3.159)	0.140*** (4.982)	0.467*** (3.502)	0.282*** (7.809)	0.663*** (3.931)
Population dispersion	-0.009*** (-9.795)	-0.005** (-2.317)	-0.006*** (-7.290)	-0.002 (-1.032)	-0.007*** (-8.276)	-0.003 (-1.570)	-0.011*** (-10.701)	-0.007*** (-3.389)
Population	-0.0004*** (-7.866)	-0.0005*** (-7.676)	-0.001*** (-9.662)	-0.001*** (-8.629)	-0.001*** (-10.252)	-0.001*** (-10.322)	-0.0001*** (-4.710)	-0.0001*** (-3.305)
Surface area	0.001** (2.485)	0.001*** (2.710)	0.001*** (3.764)	0.002*** (3.952)	0.001*** (3.846)	0.001*** (4.143)	0.0004*** (2.843)	0.001*** (2.944)
Altitude	-0.001*** (-3.011)	-0.0005** (-2.243)	-0.001*** (-3.648)	-0.001*** (-2.895)	-0.001*** (-3.519)	-0.001*** (-2.895)	-0.000* (-1.884)	-0.0004* (-1.837)
Population growth - 1793-1836	0.000 (0.378)	0.000 (0.582)	-0.000 (-1.274)	-0.000 (-0.367)	-0.000 (-1.511)	-0.000 (-0.650)	0.000 (0.757)	0.001 (1.119)
Distance to post office	-0.005* (-1.921)	-0.003 (-0.781)	-0.007*** (-2.640)	-0.007* (-1.714)	-0.005* (-1.758)	-0.004 (-1.323)	-0.002 (-0.495)	-0.000 (-0.013)
Postal taxes	0.0002*** (3.920)	0.0002*** (4.321)	0.0005*** (3.178)	0.0003*** (2.762)	0.001*** (3.939)	0.0004*** (3.444)	0.0001*** (3.398)	0.0001*** (3.181)
Industrial production	0.000 (0.432)	-0.000 (-1.016)	-0.000 (-0.308)	-0.000 (-0.764)	0.000 (0.491)	0.000 (0.383)	0.0001** (2.107)	0.000 (0.718)
Distance to prefecture	-0.003 (-1.534)	-0.003 (-1.247)	-0.003* (-1.682)	-0.003 (-1.190)	-0.003* (-1.673)	-0.003 (-1.297)	-0.001 (-0.469)	-0.002 (-1.118)
Latitude	0.096*** (4.873)	0.073*** (2.784)	0.120*** (5.731)	0.088*** (3.072)	0.102*** (5.178)	0.075*** (2.919)	0.002 (0.098)	0.021 (0.953)
Dep. with printing press	0.422*** (5.175)	0.485*** (4.694)	0.400*** (5.112)	0.496*** (4.780)	0.416*** (5.474)	0.498*** (5.159)	0.386*** (4.929)	0.371*** (4.655)
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Distance to printing press		-0.010*** (-7.31)		-0.004*** (-4.96)		-0.003*** (-5.39)		-0.001 (-0.91)
Printing presses within 100kms		0.510*** (13.61)		0.191*** (11.41)		0.195*** (13.16)		0.168*** (7.76)
Observations	5479	5479	4409	4409	5176	5176	1126	1126
R^2	0.581	0.430	0.581	0.404	0.590	0.440	0.564	0.449
$F - stat$		13.923		7.563		10.012		15.646
Hansen J p-value		0.160		0.135		0.115		0.240
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Interestingly, when computing the same estimations for the 1911 year, I still find a significant and positive impact of education, but with a lower magnitude. The effect of one additional schooling year is close to 10%, the one of enrolment to 0.25% for small municipalities²⁰⁶. As a consequence, the impact of primary schooling seems to have been at work before 1881. Between

²⁰⁶See Table 3.A9 in the Appendix.

this date and World War I, municipalities characterised by early higher educational achievements still had more economic resources per capita. However, primary instruction didn't contribute significantly to increase these resources between the two periods. This point will be further discussed in Section 7.

Table 3.8: OLS and IV estimations - Schooling years, enrolment and municipal resources

Population intervals	Log of municipal resources, francs per capita - 1881							
			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.050*** (4.636)	0.160*** (2.843)	-	-	-	-	-	-
Log of enrolment	-	-	0.125*** (4.461)	0.397*** (2.861)	0.140*** (4.982)	0.412*** (3.176)	0.282*** (7.809)	0.648*** (3.834)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.625*** (19.86)		0.228*** (15.78)		0.231*** (18.55)		0.178*** (10.18)
Observations	5479	5479	4409	4409	5176	5176	1126	1126
R^2	0.581	0.243	0.581	0.264	0.590	0.262	0.564	0.285
$F - stat$		21.302		12.077		16.203		29.876
Regression-based p-value		0.015		0.020		0.013		0.012
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

As specified before, the number of schooling years can be taken as a good proxy for the intensive accumulation of human capital as it was correlated with more subjects learnt by pupils. However, because of the labour requirements, especially in the agriculture, pupils could attend school erratically. This is likely to have led to stronger measurement errors on schooling years in rural municipalities, which the IV should correct. To be more robust on this point, I ran the same estimations using the number of subjects taught within primary schools as the explaining factor of interest. These subjects were: religious instruction, reading, writing, spelling, grammar, arithmetic, land surveying, linear drawing, geography, history and music ²⁰⁷. One more subject taught was associated with an increase of around 20% in the resources per capita in

²⁰⁷Religion, reading and writing were taught in respectively 99.4, 98.4 and 92.1% of the primary schools for which this information is available. Arithmetic was taught in 62% of the schools, grammar in 44%, spelling in 49%, geography and linear drawing in 7%, land surveying in 10%, history and music in around 3%.

1811. The respective figure for 1911 is 14% using the IV strategy²⁰⁸. This is quite close to the impact of an additional schooling year. This strengthens the idea that municipalities where people were learning more within primary schools at the beginning of the nineteenth century grew more during the century.

The results remain significant under several robustness checks. Firstly, one may fear that excluding cities with the printing press from the analysis would be insufficient to ensure that the exclusion restriction holds. To go further on this point, I implement two restrictions on the data. First, I exclude municipalities less than 13 kilometres (5%) and more than 133 kilometres (also 5%) away from location of the printing press in 1500. This eliminates potential outliers that could drive the estimations, typically municipalities far away from the printing press, with no presses around them, no primary education and low economic resources. Also, it reinforces the reliability of the exclusion restriction by letting aside municipalities that could have benefited from economic spillovers from towns with a printing press. All estimates remain significant, with a slightly lower magnitude since one additional year of schooling is now associated with a 12.6% increase in economic resources. A 1% increase in enrolment raises resources by around 0.3%²⁰⁹.

One additional robustness check on this point consists in excluding more municipalities that could have benefited from economic spillovers. I run the same estimations but keeping only the municipalities more than 35 kilometres away from the printing press, which amounts to letting aside the 25% closest to the press. One again, this doesn't modify the outcomes which remain very close to the general case²¹⁰. The estimations computed using the number of printing presses within 100kms are therefore not highly dependent on the municipalities close to the printing press, which reinforces the strength and reliability of this instrument.

These results are also robust to the selection of different radii to compute the number of printing presses. Using a 75kms or 150kms radius doesn't alter the significance of the estimates²¹¹. The magnitude of the outcomes is higher when using the 150kms radius compared to the 75kms one, especially for big towns. This is most likely due to the loss of precision caused by the use of this instrument as printing presses located far away from municipalities are now entering the instrument. Standard errors associated to schooling years and enrolment are indeed higher in this case.

Moreover, the effect of schooling years remains significant when separating municipalities with the same population intervals as for enrolment rates. The magnitude of the effect is somewhat higher for bigger towns, as is the impact of enrolment. Using either distance to the nearest printing press or the number of printing presses within 100kms as an instrument returns significant results. The distance instrument is however less precise and powerful, as noted before, especially for big towns²¹².

²⁰⁸See Table 3.A10 in the Appendix.

²⁰⁹See Table 3.A11 in the Appendix.

²¹⁰See Table 3.A12 in the Appendix.

²¹¹See Table 3.A13 in the Appendix.

²¹²See Table 3.A14 in the Appendix.

Finally, the effect of primary schooling on the development of municipalities is also robust to the control for spatial autocorrelation in the error term. I computed Conley standard errors (Conley, 1999) based on four different radii of 25, 50, 75 and 100 kilometres following the methodology used in (Ashraf and Galor, 2011). GMM estimations deliver significant results for any specification, whether considering municipalities in the bottom 75% or top 25% in terms of population level²¹³.

5.4 The Within-Department Effect

When studying the effect of education on the economic development of municipalities, it is interesting to keep only the within-department variation. Indeed, if municipalities with higher educational achievements had also higher economic resources, this may not have been the case in all departments. The results may therefore be driven by some of them, most likely the north-eastern ones where primary education was the most developed. I introduce department fixed effects in Table 3.9 to check for this differentiated impact. Finding a significant association between education and development after this introduction would be reassuring. Indeed, it would mean that the previous estimations are not driven only by a few departments and by potential omitted variables positively correlated to both education and future growth within them. Also, I separate the estimations according to the median ratio of municipalities with primary schools within departments²¹⁴. The idea behind this is that primary schooling may have contributed differently to the economic development of a municipality depending on the educational performance of the surroundings areas.

I find that education was indeed influencing significantly economic development, but only in the eleven departments with a relatively low level of educational achievement. These departments are the following: Cher, Corrèze, Cotes d'Armor, Finistère, Indre, Indre et Loire, Loire Atlantique, Lozère, Morbihan, Nièvre and Saône et Loire. Within these departments, one additional year of schooling was on average associated with a 8% increase in economic resources in 1881. A one-percent increase in enrolment was linked to a 0.3% increase in resources. The instrument used becomes weak when working on departments well-endowed in primary schools. The impact estimated is only reliable for enrolment in municipalities less than 1 109 inhabitants. However, this coupled with the absence of significant results using the OLS is at least an indication that primary schooling was not significantly associated with economic growth within these departments.

Therefore, when primary education was well spread between municipalities, a higher enrolment or number of schooling years was not significantly influencing economic development. This was actually to be expected. Indeed, I showed in another work that municipalities in the north-eastern part of France were characterised by a higher presence of primary schools, but also that enrolment was on average higher in these departments, pupils attending schools for a longer

²¹³See Table 3.A15 and Table 3.A16 in the Appendix.

²¹⁴I don't cluster standard errors at the district level in the estimations. Indeed, the number of clusters would be too low to be reliable (Angrist and Pischke, 2008). Robust standard errors are therefore computed instead.

number of years and learning more subjects (Montalbo, 2019b). Therefore, since education was more homogeneously developed in the departments above the Saint-Malo/Geneva line, it is logical not to find any significant influence of education when focusing on this area and adding department fixed effects.

In departments endowed with a low presence of primary schools, the variations in educational attainment were sufficiently high to impact the economic development of municipalities. Moreover, the restriction to cities below 1 109 inhabitants for enrolment and schooling years demonstrates that their effect was not driven by the higher educational achievement of big towns. This constitutes an additional indication that primary instruction impacted positively economic growth and that its effect was not confounded with or driven by the one of past economic resources.

Table 3.9: OLS and IV estimations - Schooling year, enrolment and municipal resources within departments

Population intervals	Log of municipal resources, francs per capita - 1881											
	Deps. with % municipalities with schools < median						Deps. with % municipalities with schools > median					
	Bottom 75%		Top 25%		Bottom 75%		Top 25%					
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)	OLS (9)	IV (10)	OLS (11)	IV (12)
Schooling Years	0.020*** (3.154)	0.088*** (2.795)	-	-	-	-	0.002 (0.707)	0.006 (0.074)	-	-	-	-
Log of enrolment	-	-	0.045*** (3.117)	0.290*** (2.808)	0.094*** (3.404)	0.303** (1.991)	-	-	0.005 (0.594)	0.015 (0.118)	0.095** (2.456)	0.045 (0.129)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years		Enrolment rate				Schooling years		Enrolment rate			
Printing presses within 100kms		0.458*** (7.33)		0.143*** (6.02)		0.115*** (4.32)		0.112* (1.90)		0.073*** (3.20)		0.080* (1.82)
Observations	1513	1513	1538	1538	770	770	2860	2860	2871	2871	356	356
R^2	0.654	0.299	0.652	0.218	0.655	0.321	0.694	0.322	0.696	0.358	0.613	0.387
$F - stat$		54.154		36.538		18.972		3.636		10.304		3.456
Regression-based p-value		0.013		0.007		0.143		0.963		0.938		0.888

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres. Departments below the media level are: Cher, Corrèze, Cotes d'Armor, Finistère, Indre, Indre et Loire, Loire Atlantique, Lozère, Morbihan, Nièvre and Saône et Loire. Departments above the median level are: Ardèche, Ardennes, Gard, Gers, Loiret, Marne, Oise, Seine et Marne, Deux Sèvres and Vaucluse.

I also run within-departments OLS estimations to investigate the potential positive or negative externalities of education on the growth of municipalities without schools. I find no indications of negative externalities in departments with a lower presence of primary schools. Therefore, the surplus of resources associated with enrolment and schooling years didn't come from a diversion of income from municipalities without schools to the ones with high educational achievements. The same computations on departments well-endowed in primary schools return a negative correlation between the future growth of municipalities without schools and the number of schools within a circle of 50 kilometres around them. This is also true for the average

enrolment rate within the same distance bound²¹⁵. A one-percent increase in the average enrolment was associated with a 0.4% decrease in resources per capita in 1881. Therefore, municipalities without schools grew less if the surrounding areas were characterised by high education achievements within departments well-endowed in schools. This indicates a potential diversion of resources at the expense of municipalities without schools in these departments, either through a movement of economic activities or people. In any case it seems that, as education became more common, municipalities with no schools had more difficulties keeping up with the others in terms of economic development.

6 Education Quality and Economic Development

A significant part of the education economics literature focuses on the effect of teaching quality on the volume of knowledge learnt. This quality, positively related to educational achievement (Rockoff, 2004), (Rivkin et al., 2005), has been proxied by several variables. Class size is one of them (Angrist and Lavy, 1999). Teachers' salary has also been shown to influence positively test scores, whether at the country (Dolton and Marcenaro-Gutierrez, 2011) or at the school level (Nickell and Quintini, 2002), (Britton and Propper, 2016). The main argument behind this influence is that higher salaries would attract better-qualified teachers (Figlio, 1997), their level of qualification being itself positively correlated with teaching quality (Behrman and Birdsall, 1983), (Ehrenberg and Brewer, 1994). Salary may be the best proxy for quality (Hanushek and Rivkin, 2006), even if incentives within classrooms seems to play a major role in increasing teaching and educational achievements (Hanushek, 2003). A higher quality, also proxied by pupil/teacher ratios, impacts positively individual earnings (Card and Krueger, 1992a), (Card and Krueger, 1992b).

In parallel with these microeconomic studies, the impact of education quality on growth also came under scrutiny. At the macroeconomic level, quality has been proxied by test scores, reflecting the cognitive skills' spread within the labour force. Quality is therefore to be understood here as an educational output, while it is an input in the microeconomic studies. Higher scores, often measured at the secondary or higher level, were shown to strongly influence economic growth within the 1960-2000 time period (Hanushek and Kim, 1995), (Hanushek and Kimko, 2000), (Barro, 2001), (Hanushek and Woessmann, 2012). Also, both the share of people mastering basic skills, or the share of those performing highly in test scores seem to matter for economic growth (Hanushek and Woessmann, 2008).

Thanks to the information reported in the Guizot survey, I can provide some evidence about the relation between schooling quality and economic development in nineteenth-century France. A crucial difference between primary schools at that time was the potential financial support provided by municipalities to education. Indeed, teaching was a hard profession (Prost, 1968), especially when the school was private and only financed by schooling fees paid by families.

²¹⁵See Table 3.A17 in the Appendix. Taking other distance bounds as 100 kilometres for example wouldn't change the outcomes.

In this case, the teacher could only rely on his own ability to attract a sufficient number of pupils so that he could benefit from a decent remuneration. If the teacher was not good enough to do so, he would often try his luck in another municipality (Meunier, 1981). Also, without municipal support, teachers were forced to find a place to practice on their own. This could be their house in the best case, but also a barn in winter, the meadows during summertime (Lorain, 1837).

Municipalities could invest in primary education by hiring teachers for a year and providing them with a fixed salary. They could also grant them with an accommodation, a classroom (often a room in the town hall), or another municipal occupation. In this last case, they were offering the teacher to be paid on a regular basis if he would also serve as a mass cantor, a town clerk, or any occupation useful to the municipality. Therefore, municipal investment was increasing the financial stability of the teachers and improving their working conditions. In another work, I showed that this municipal investment was associated with the recruitment of better-qualified teachers, a higher teaching quality (as evaluated qualitatively by the inspectors from the Guizot survey) and higher educational achievements proxied by the average number of schooling years (Montalbo, 2019b). This positive association can be explained by a higher involvement of teachers. Indeed, as municipal authorities could recruit a new teacher if the incumbent one was deemed inefficient, public grants were functioning as performance rewards. This is in line with the recent literature identifying a positive effect of performance pay on teachers' efficiency and test scores (Lavy, 2002), (Lavy, 2009), (Muralidharan and Sundararaman, 2011)²¹⁶. In this work, I take municipal grants instead of the progress of pupils as indications of teaching quality. This is done in order to avoid relying on the evaluation of quality made by the inspectors of the Guizot law and which is subject to measurement errors and subjectivity biases. The strong association between these subsidies and the inspectors' evaluation of quality is indicating that this approximation is a fairly good one.

Descriptively, there was a positive association between the indicators of municipal investment and the future economic resources of municipalities. The resources of municipalities paying teachers were on average of 10.01 francs per capita in 1881, against 5.83 for those which didn't. The respective figures for the accommodation, other occupation provisions and second degree certificate are of 11.28 against 7.95, 10.63 against 6.54 and 9.58 against 7.80²¹⁷.

Therefore, in Table 3.10, I evaluate if better working conditions and a higher teaching quality were associated with an increase in municipal resources using OLS estimations. I only keep municipalities with a primary school in the estimations so that the effect of quality wouldn't be mingled with the influence of a primary school's presence. This approach is a mix between the micro and macro ones as it connects directly schooling inputs to economic resources. I introduce dummy variables indicating if the school was subsidised or not by the municipality in the estimations, along with the standardised salary provided to the teacher (only when he was

²¹⁶More mixed evidence are presented in (Glewwe et al., 2010). See (Woessmann, 2011) for a cross-country comparison.

²¹⁷The difference between these figures is always significant at a one-percent level. See Table 3.A18 in the Appendix.

granted with such a salary). I gather accommodation and classroom grants since they were only 88 cases of municipalities providing an accommodation but not classroom. Inspectors seem to have considered that when a teacher was provided with an accommodation, he could practice at home and was therefore also granted with a classroom.

I also evaluate the effect of teachers' certification level. From 1816 onwards, a certificate composed of three different degrees, the third one being the lowest on the hierarchy, was a prerequisite for teaching. The third degree could be obtained thanks to a minimum mastering of numeracy and literacy. With additional notions of spelling and calculus, they were likely to obtain the second degree. The first one was only accessible for teachers mastering grammar, land surveying, geography and arithmetic. I only introduce the second-degree certificate, obtained by around 38% of the teachers, in the estimations since nearly no teachers, around 1%, had obtained the first-degree one in 1833. Also, 6% of the teachers still didn't abide by the 1816 law and had no certificate in 1833. Therefore, the effect computed is of having a high-level certificate compared to a low-level one or to no certificate.

At the same level of education achievement in terms of schooling years and enrolment, municipalities which increased teachers' financial ease had higher economic resources per capita 50 years later. Providing teachers with a fixed salary was associated to a 12.7% increase in resources in 1881, one standard deviation in this salary with a 16.2% increase. Granting teachers with another municipal occupation was also positively linked to resources, with a magnitude around 8.5%. This is very likely to reflect the influence of schooling quality. The effect of the accommodation or classroom grant is more dubious and there is no significantly relation between resources and the certification level.

It would too bold to assert that these relations are causal. Municipalities with initial higher resources were more likely to invest in primary education and to be more developed at the end of the century. However, the controls on initial resources should account partly for this in the estimations. Moreover, controlling by enrolment improves this point. Indeed, on average, paying the schooling fees for one child amounted to spend between 1 and 1.2 francs per month. This was equivalent to the daily wage of an industrial female worker and between 50% and 71% of an industrial male daily wage. The agricultural survey of 1852 indicates the annual spendings and savings of a day-worker family with three children²¹⁸. Assuming that one of them was working and, depending on the hypotheses made on the attendance of the two children left (both 12 months, one 12 and the other 6 or both 6 months) schooling fees represented respectively 16, 21 or 26% of total savings. The fees were therefore a strong economic barrier to the schooling of children coming from destitute backgrounds. This why most of these families were not schooling their children and were sending them all to work (Villermé, 1829). Therefore, municipalities where the same proportion of children were attending schools should not have been too far in terms of families' economic resources. As a consequence, schooling quality should explain a fair part of the association found between municipal investment and economic

²¹⁸Those were clearly the poorest among agricultural workers since, for example, food represented between 57 and 79% of their annual spendings, with a mean of 66%.

resources.

Table 3.10: OLS estimations - Public primary schooling and municipal resources

	1881					1911				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fixed salary	0.127*** (2.999)	-	-	-	-	0.086*** (2.867)	-	-	-	-
Fixed salary amount	-	0.162*** (5.417)	-	-	-	-	0.085*** (3.260)	-	-	-
Accommodation or classroom	-	-	0.067 (1.596)	-	-	-	-	0.068** (2.338)	-	-
Other municipal occupation	-	-	-	0.085* (1.869)	-	-	-	-	0.069* (1.886)	-
2nd degree certificate	-	-	-	-	0.031 (1.181)	-	-	-	-	0.012 (0.625)
Log of enrolment	0.305*** (6.786)	0.333*** (6.659)	0.317*** (6.764)	0.319*** (6.608)	0.320*** (6.725)	0.247*** (5.833)	0.245*** (4.793)	0.253*** (5.901)	0.255*** (5.866)	0.259*** (5.997)
Schooling Years	0.025* (1.952)	0.010 (0.725)	0.025* (1.988)	0.023* (1.797)	0.026** (2.063)	0.026* (1.945)	0.023 (1.531)	0.026* (1.938)	0.025* (1.859)	0.027** (2.009)
Demographic controls	Yes									
Economic controls	Yes									
Distance controls	Yes									
Observations	3031	1985	3031	2986	3031	3029	1983	3029	2984	3029
R^2	0.608	0.579	0.605	0.605	0.604	0.607	0.547	0.607	0.605	0.604
Clusters	76	73	76	76	76	76	73	76	7	76

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003).

Notes: The fixed salary amount effect is only computed for municipalities providing a fixed salary to the teacher. This variable is standardised. Other indicators of municipal investment are dummy variables equal to one if the grant at stake was provided to the teacher.

Quality is also likely to have influenced educational achievements, even with no increase in enrolment or schooling years. Indeed, the threat to lost municipal support was a strong incentive for teachers to invest in their work and improve their teaching quality. Therefore, if pupils were learning better all year long, they would maybe even have needed less time to master the basics of literacy and numeracy. Also, a better education was likely to have lasting effects on pupils through the accumulation of a more deeply-rooted knowledge²¹⁹. In order to give further credit to the association between quality and economic development, I now turn to a matching estimation technique (Rosenbaum and Rubin, 1983)²²⁰.

The idea here is to estimate a propensity score for municipal investment in education. Treated units, municipalities which did invest in primary schooling, are then matched with control units, municipality which did not, according to this score. Therefore, I let the certification variable aside. When using this technique, the choice of covariates is essential as matching relies on

²¹⁹It was for example common for people, during their lifetime, to learn several times how to read in order to master it properly (Laqueur, 1976). Teaching quality may have reduced this need to go over the same difficulties again and again.

²²⁰See (Heckman et al., 1997) and (Dehejia and Wahba, 1999) for influential papers using the matching technique. See also (Lalonde, 1986) and (Smith and Todd, 2005) for a discussion about the reliability of this technique.

the unconfoundedness assumption, which states that treated units are selected on observables. Therefore, the assignment to treatment is supposedly independent of the outcomes, conditional on the covariates. In this case, it means that the decision of municipalities to subsidise schools could be fully explained by the selected covariates. Omitting important variables can seriously increase the bias in resulting estimates (Heckman et al., 1997), (Dehejia and Wahba, 1999). Also, the covariates should influence simultaneously the future economic resources of municipalities and their propensity to subsidise primary schooling.

I selected the following set of covariates: log of enrolment, schooling years, population in 1833, population dispersion, surface area, the distance to post office, postal taxes, industrial taxes, the number of printing presses within 100kms. I also added the distance of municipalities to the cities of Lyon, Paris, Marseille, Nantes, Bordeaux, Strasbourg, which could have influenced their economic development. These variables should account for the economic resources of municipalities that enabled them to invest in education, as well as for the cultural influence that prompted them to do so. Also, the education covariates should reinforce the comparability of the matched observations whose educational differences rely only on municipal investment. In Figure 3.6, I represent the propensity scores associated to the municipal grants, estimated using a logit specification. There is a substantial overlap in the distributions for municipalities subsidising education and those which did not. This is essential for the econometric identification with the matching technique.

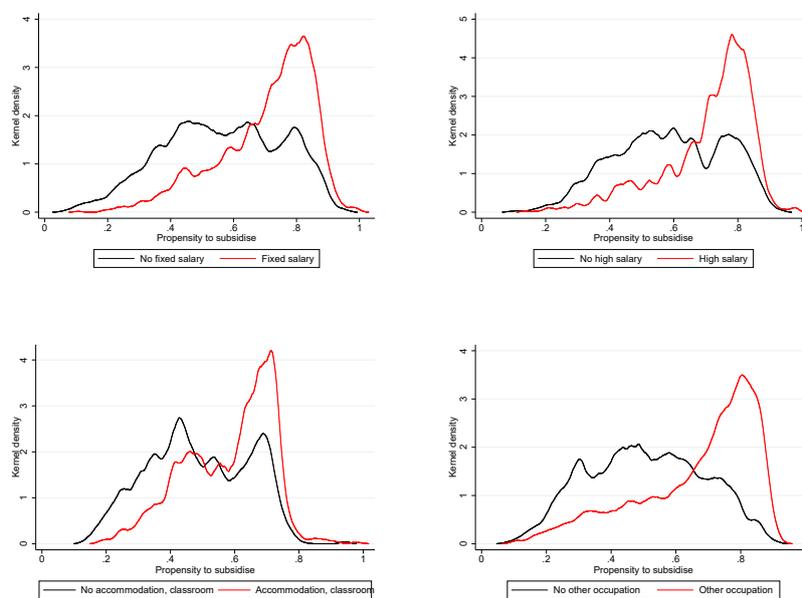


Figure 3.6: Propensity score densities

Source: Guizot, industrial, postal surveys, IGN data. (Motte et al., 2003) and *La Situation Financière des Communes*.

Note: Propensity scores for the municipal grants are displayed in these graphs.

In Table 3.11, I report the nearest-neighbour matching estimates on municipal subsidies²²¹. In order to include the fixed salary amount, I created a dummy variable indicating if teachers were benefiting from a "high salary" or not. 50% of the municipalities providing a salary were paying teachers less than 200 francs a year. I took this median value as a threshold to build the variable²²². The effects found are in compliance with the ones reported in Table 3.10. Providing teachers with an accommodation or a classroom had no influence on economic development. A higher financial support, embodied by a fixed salary, its amount, and another municipal occupation was positively related to the future resources of municipalities. As before, the effect is decreasing in time. The impact of a fixed salary grant on future growth is close to the one of an additional schooling year, and to an increase of 30% in enrolment.

Table 3.11: Matching estimations - Public subsidies and log of municipal resources, francs per capita

	1881				1911			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fixed salary	0.186*** (4.975)	–	–	–	0.119*** (5.058)	–	–	–
High salary	–	0.104** (2.518)	–	–	–	0.079** (2.204)	–	–
Accommodation, classroom	–	–	0.014 (0.497)	–	–	–	0.036 (1.526)	–
Other occupation	–	–	–	0.108*** (2.782)	–	–	–	0.075** (2.229)
Observations	3047	2041	3047	3002	3046	2039	3046	3001

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys, IGN data. (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: All variables are dummy ones, indicating if the municipality at stake was subsidising primary education. The *High salary*, variable is equal to one if the municipality was paying the teacher more than 200 francs per year, which is the median fixed salary level.

In order to give further reliability to these estimations, I checked that the covariates I use are balanced between the treated and control municipalities in the matched sample. I did so for the fixed salary provision and found no statistically significant difference in the average values of each covariate between the two groups. Moreover, the bias associated to the covariates between the groups (Rosenbaum and Rubin, 1985) is greatly reduced within the matched sample, from an average value of 16.9% to 2.6%²²³. Therefore, there is no issue of selection bias between the two groups in the matched sample.

²²¹This, compared to taking several neighbours, has the advantage of minimising the bias associated with the matching estimation.

²²²In these estimations, I use the *teffects psmatch* command in Stata. This use is recommended for the computation of the standard errors of matching estimates. See (Abadie and Imbens, 2016) for example.

²²³These tests are computed using the *psmatch2* command in Stata.

Also, as a robustness check, I computed the same estimations using a nearest-neighbour matching, but adding restrictions on the propensity score. First, I restricted it to the common support. Second, I restricted the selection of neighbours using a caliper bounded to 0.2 standard deviation of the propensity score, as recommended in (Austin, 2011) for minimising the bias related to the estimations. This didn't alter the outcomes for what regards their significance or the magnitude of the estimates²²⁴.

7 Transmission Channels

Why did primary education contribute to the economic development of municipalities ? Was there an unsatisfied demand for academic skills that would explain the higher economic performance of municipalities where education was more developed ? Was this due to another phenomenon, for example migrations which were so pronounced in the second part of the 19th century ? In the literature on education, there are three main transmission channels identified between education and growth. Firstly, education increases the accumulation of human capital in the labour force, then productivity and the level of output. This is the channel describes in the neoclassical models (Mankiw et al., 1992). Secondly, education may increase the innovation capacity of the economy. The new technologies, products and processes then contribute to promote growth. This is the channel advocated by the endogenous growth theorists (Lucas, 1988), (Romer, 1990). Last but not least, education can facilitate the diffusion and transmission of knowledge and new information, helping to implement successfully new technologies which could be devised by others. This contributes to enhance economic growth (Nelson and Phelps, 1966), (Easterlin, 1981).

Before discussing the channels, it is interesting to point out that primary schooling positively influenced the level of economic resources both in 1881 and 1911, but that it didn't enhance growth between these two dates. Municipalities with an early well-developed primary education grew at a lower rate during this period. Descriptively, the presence of a primary school in 1833 was associated with a growth of economic resources around 115% between 1881 and 1911, against 143% in municipalities without schools in 1833²²⁵. Therefore, the positive impact of primary education was mainly concentrated from the beginning of the century to the 1880s, during the period of high growth. This indicates a progressive convergence between municipalities towards the end of the century. The results is coherent with studies showing that a convergence in primary schooling took place in nineteenth-century France, even before the Ferry Laws of 1881-1882 which made primary education mandatory (Diebolt et al., 2005). As shown in Table 3.9, primary schooling was less likely to influence significantly the growth of municipal resources when it was relatively well-spread across all municipalities. The Ferry Laws certainly dealt the fatal blow to the impact of primary education on development, as it

²²⁴See Table 3.A20 in the Appendix.

²²⁵OLS and IV estimations exhibit this negative association between primary schooling and the 1881-1911 growth rate of municipal resources. See Table 3.A21 in the Appendix. The estimates' magnitude is high, but in line with the descriptive statistics.

has been the case in the early 1870s in England (Mitch, 1984).

Among the transmission channels, the second one may be the easiest to discuss and reject as it mostly applies to countries. Indeed, it is highly unlikely that variations in enrolment rates and in the number of years spent within primary schools conducted some municipalities to benefit from a higher innovation rate than others. More people mastering literacy and the basics of numeracy, or even with a secondary education, was not leading to more innovations. In the American and British cases, it has been shown that inventors of the nineteenth century didn't perform particularly well in terms of educational achievement (Khan and Sokoloff, 1993), (Khan and Sokoloff, 2004), (Khan, 2018). It is true that there was a positive correlation between basic education and innovation in high-tech industries in late nineteenth-century Prussia (Cinnirella and Streb, 2017). However, this is valid at the level of counties. Even if education did influence positively the innovation at the local level in France, the number of municipalities concerned was certainly too low to explain the strong effect found between primary education and the development of municipalities. Therefore, the third transmission channels seems to bear more explaining power for what regards the link between education and technological progress.

Indeed, more education people may have been less reluctant to implement new technologies, to use new tools or to adopt new production processes. A good example illustrating this point is the "green revolution" in India. It has been shown that rural households with at least one adult with a primary education were more likely to use the high-yielding variety seeds introduced in the late 1960s. This in turn contributed to increase the returns to schooling, especially in areas with higher past growth rates (Foster and Rosenzweig, 1996). Either more educated people used earlier these seeds or they used them better. In this perspective, technology is therefore more likely to increase growth when the initial level of instruction is higher. This has also been studied in the case of American agriculture in the late 1950s (Welch, 1970) and manufacturing industries between 1960 and 1980 (Bartel and Lichtenberg, 1987)²²⁶.

This is very likely to have been valid for France during 19th century, especially in the agricultural sector. Indeed, the implementation of innovations in industry, which multiplied from the 1830s onwards, were certainly more dependent on the location of natural resources and on the economic resources of manufacturers. It is true that tradition and the fear of making useless investments may have deterred the diffusion of innovation in industry, but most likely to a lesser extent. The location of steam engines for example, whose number jumped from 150 to 6 000 between 1816 and 1850, was highly dependent on the presence of coal and mines and therefore strongly concentrated in the north-eastern part of France (Woronoff, 1998). Other important industrial innovations, as the Bessemer process invented in 1856 for the mass production of steel from molten pig iron, was implemented within big factories and had little to do with primary education. However, the diffusion of mechanised work in the textile sector disseminated through the French countryside was more likely to be linked to education. The water frame of Richard Arkwright or the spinning jenny of James Hargreaves could be implemented in small

²²⁶This argument is also closely related to (Glaeser, 2003) and (Glaeser et al., 2004) who show that human capital influenced strongly the growth of cities when economic (technological) shocks were affecting them, thanks to the higher "ability to deal with disequilibria" of people (Schultz, 1975).

manufactures and at a relatively low cost. More educated manufacturers may have been more rapidly aware of the potential benefits they could draw from these innovations, and therefore more eager to implement them within their factories.

Within the agricultural sector, the spread of fertilizers, which began to surge in the second part of the century (Clout and Phillips, 1972), may have been facilitated by the proximity of farmers to the new agronomy. However, it is difficult to disentangle the effect of education from the one of income and soil composition. Indeed, this spread remained highly concentrated in the Paris basin during the 19th century. The adoption of innovations related to the plough also began in the richer and more educated areas in France. The adoption of the Dombasle plough in the 1820s and the progressive transition to the Brabant one at the end of the century followed this pattern (Beltran and Griset, 1994). Many factors can have influenced the differentiated spread of the plough as the presence of horses as draught animals, the composition of the soil and cultivations, the purchasing power of farmers, ... But surely resistance to the introduction of new techniques played a significant role (Duby and Wallon, 1976). Education may therefore have facilitated the early adoption of these techniques. The same is true for the transition from the sickle to the scythe, the introduction of the threshing machines in the 1860s and of the harrow, which took place firstly in the north and north-eastern parts of the country.

The first transmission channel mentioned, the increase in productivity, can explain economic development only if some jobs were better performed with a higher primary education, or if a higher educational achievement was enhancing the creation of more productive jobs. At first sight, the second reason seems to have been the more relevant historically. Indeed, even if the returns to schooling were likely to be high in the mid-19th century (Mitch, 1984)²²⁷, there was only a small share of jobs for which literacy was absolutely necessary. For instance, the 1841 census for England indicates that 4.9% of men and 2.2% of women had such an occupation. The respective percentages for jobs with no need of literacy were of 49.7% and 24.7% (Mitch, 1993)²²⁸.

In the case of industry, there is an ongoing debate about its impact and relation with education. Supporters of the "deskilling hypothesis" (Sanderson, 1972), (Nicholas and Nicholas, 1992) argued that early industrialisation and the progressive introduction of large-scale factories using steam-power were mainly skill-saving, favouring the development of low-skilled jobs (de Pleijt and Weisdorf, 2014), (de Pleijt, 2018). This was especially true if steam engines were favouring the use of machines on which children were performing secondary tasks in assisting older workers, as putting together broken pieces of thread on spinning mules in the textile sector (Nardinelli, 1980), (Nardinelli, 1990), (Humphries, 2012). In the Nord department, for example, industrial districts were found to be characterised by relatively low literacy rates between 1831 and 1843 (Leblond, 1970). By the same token, the presence of a developed textile sector was correlated with a lower literacy in the diocese of Rouen at the end of the 18th century (Furet and Ozouf, 1977b). However, showing that industry led to a fall in literacy is not ob-

²²⁷As they are for example today for developing countries, higher than the returns to secondary or higher education (Psacharopoulos and Patrinos, 2004).

²²⁸See also (Galor and Moav, 2006) on this point.

vious (Schofield, 1973), (Corbin, 1975), (de Pleijt et al., 2016). In the case of France, there seems to have been a complementarity between technology and human capital (Franck and Galor, 2017). Similarly, Diebolt et al., 2017a found that the number of steam engines within departments was positively associated with literacy rates and primary schools' presence in the first part of the nineteenth century. They interpret this as being due to the fact that basic knowledge was required in industry in the first part of the century, while a more upper-tail one became complementary to industrial activities in the second part. In another work, I showed that industrial activities influenced positively primary schooling through an income effect on municipal resources, but that they didn't increase significantly the accumulation of human capital within primary schools (Montalbo, 2019a).

Still, one has to remember that higher enrolment rates and primary schooling years were often synonymous with more people knowing how to read and write and the basics of numeracy. This very simple improvement in education may have increased the productivity in many jobs. A higher capacity to keeping accounts for example, or the possibility to find somebody nearby able to do so, was certainly useful for merchants, bakers, butchers, ... and all people who had at some point to deal with numbers or contracts. This potential increase in productivity is exemplified by the strong positive correlation in the mid-nineteenth century between education and the level of industrial or agricultural wages at the department level (Chanut et al., 1995). Also, returns to schooling have been evaluated as higher in rural compared to urban areas in Victorian England in terms of occupational mobility (Mitch, 2005). Therefore, even in the agricultural sector, education is very likely to have contributed to increase the share of skilled jobs and productivity. Using the industrial data of 1839-1847, I also find a positive association between primary schools' presence in 1833, schooling years, enrolment rates and the industrial male wages²²⁹. This is likely to indicate a higher productivity of educated workers in industry around the mid-nineteenth century in France. Moreover, the demand of literate people increased in industry during the second part of the century, notably with the need of reading plans (Mitch, 1993). Finally, and maybe to a lesser extent, manufacturers might have looked for a more disciplined workforce likely to be more productive and less often absent from work (Johnson, 1970), (Rosanvallon, 1985).

Primary education may also have favoured the concentration of more productive people and jobs. Literate and more skilled parents can for example have decided to migrate to a given municipality where primary schooling was well-developed because they had a higher preference for education. This Tiebout sorting (Tiebout, 1956) would have reinforced the positive effect of education on economic resources by gathering more productive people. Moreover, if past education helped developing attractive jobs requiring more skills, these people would also have migrated in order to seize these better working opportunities. Generally speaking, numerous studies have shown that more educated people were migrating farther away in the 19th century (Heffernan, 1989) (Hoyler, 1998), (Rosental, 2004), (Bonneuil et al., 2008). Scholars have insisted on the idea that job opportunities were guiding these migrations. Also, education was

²²⁹See Table 3.A22 in the Appendix.

facilitating migration by increasing the network and communication means of migrants. Migrations from villages to villages which were numerous before the 1880s (Rosental, 1994) were also greatly dictated by education (Rosental et al., 2000). Therefore, instruction may have influenced the concentration of skill-demanding jobs, this in turn attracting more educated people who reinforced the productive advantage of the municipalities. This cumulative effect is likely to have played an important role in explaining the differentiated economic development of municipalities.

Moreover, the presence of more educated people has certainly played a role on the economic performance of adults living in the same municipality (Marshall, 1890), (Moretti, 2004a), (Moretti, 2004b)²³⁰. Localised educational spillovers may have taken different forms: a positive influence on co-workers' performance in a given plant, a higher agricultural production influencing nearby farmers to adopt the same technology and techniques, a simple gesture of solidarity as helping another inhabitant with a complicated tasks, ... Also, the growth of British cities between 1861 and 1961 has been influenced by the composition of their labour-force. A higher concentration of business professions producing and transmitting information²³¹ helped increasing economic efficiency (Simon and Nardinelli, 1996). This might have also influenced the development of bigger towns in the French case.

8 Conclusion

Major economic and social events of the 19th century have left a lasting mark in French history. First, the alternation of political regimes resulted in the advent of the republican system. Second, this period was characterised by the industrialisation of the country, along with the progressive modernisation of the agricultural sector. Primary education also developed strongly during this century, in link with growing economic resources and a higher demand for academic skills on the labour market. Important laws sustained this extension by increasing the supply of schools. The Guizot law of 1833 initiated this movement by making mandatory for municipalities more than 500 inhabitants to open and fund a primary school for boys. Then, the Falloux and Duruy laws of 1850 and 1867 extended this legislation to girls. Finally, compulsory schooling was enacted by the Ferry laws of 1881 and 1882.

Primary education spread was spatially differentiated between French departments and municipalities before 1833. Some areas, as the north and north-eastern parts of the country, were already characterised by high educational achievements in the early 19th century. This educational edge played an important role in the subsequent development of the municipalities.

Indeed, whether using a regression discontinuity estimation technique around the 500-inhabitant threshold created by the Guizot law, or instrumenting primary education by the long-term establishment of printing presses lead to the same conclusion. Municipalities where an early

²³⁰The evaluation of the external effects of education have been debated. See for example (Acemoglu and Angrist, 2000) for a counter-example.

²³¹Namely: bankers, brokers, insurance agents, accountants, auctioneers and commercial travellers.

investment in primary schooling was present, either by families alone or with the financial assistance of local authorities, had a higher level of economic resources per capita at the end of the 19th century and just before World War I. Schooling quality, proxied by the municipal investment in schools, also influenced positively municipal development. Therefore, it is within municipalities where education was well-developed and public that the effect of primary schooling on economic development was the strongest.

This positive effect of education on growth was concentrated before the end of the century. The progressive educational convergence between municipalities contributed to diminish its impact. Basic primary schooling appears to have been an important factor in explaining the growth of municipalities during the century of industrialisation and modernisation in France. Several transmission channels may account for this positive impact. The quicker adoption of new and more productive techniques in the agriculture is one of them. The concentration of more productive people and jobs through migrations is another. These two are the most plausible factors behind the association between education and development in nineteenth-century France.

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Appendix

Data and descriptive statistics

Table 3.A1: Data representativeness, means and t-tests

	France	Municipal level sample	t-test
Population - 1833	91 948	85 794	NS
Number of municipalities	105	90	***
Percentage of population scattered	49.4	55.4	*
Average altitude - meters	300	211	***
Surface area - hectares	1 566	1 869	***
Percentage of municipalities with schools	71.5	60.8	***
Primary schools per 100 municipalities	215	79	NS
Teachers with a fixed salary per 100 municipalities	48.1	51.9	NS
Teachers with an accommodation per 100 municipalities	43.6	46.8	NS
Pupils per 100 children and single people	19.9	16.5	**
High heights among conscripts (%)	32.5	30.2	*
Percentage of municipalities with factories	17.2	21.6	**
Percentage of municipalities with factories > 20 workers	7.6	8.3	NS
Number of industrial workers	3 592	2 531	NS
Industrial male worker daily wage - cents of francs	192	187	NS
Taxes on industrial activities - francs per year	12 733	12 591	NS
Total agricultural area - hectares	143 903	150 892	NS
Land value by hectare - francs	1 825.6	1 644.5	**
Food % in day-workers family spendings	66.4	66.5	NS
Male day-workers daily wage - francs	1.42	1.38	NS
Female day-workers daily wage - francs	0.89	0.87	NS
Day-workers per 100 self-employed	103.6	111.1	NS
Share-croppers per 100 self-employed	10.3	10.9	NS
Tenant farmers per 100 self-employed	16.8	27.8	***

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Guizot, industrial, agricultural and postal surveys. IGN data and (Motte et al., 2003). Military data on conscripts from (Aron et al., 1972).

Notes: All figures are computed at the level of districts. The average population in each district was respectively around 85 794 inhabitants for those belonging to the municipality level sample and around 91 948 inhabitants for the entire France. The difference between the two is non-significant.

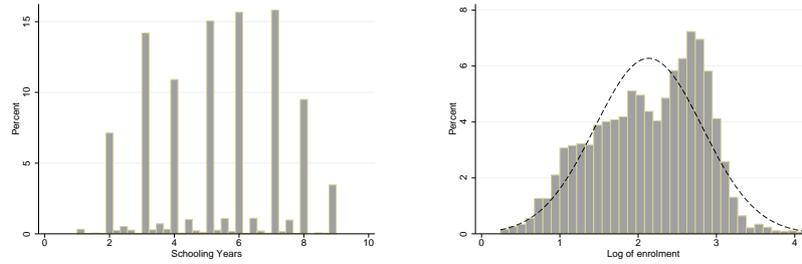


Figure 3.B1: Histograms of enrolment and schooling years

Source: Guizot survey.

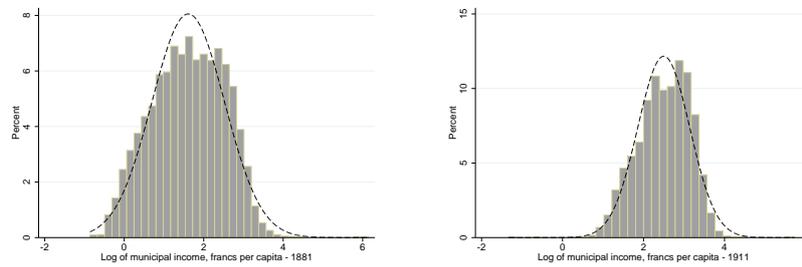


Figure 3.B2: Histograms of the log of municipal resources, 1881 and 1911

Source: *La Situation Financière des Communes*.

Regression discontinuity design

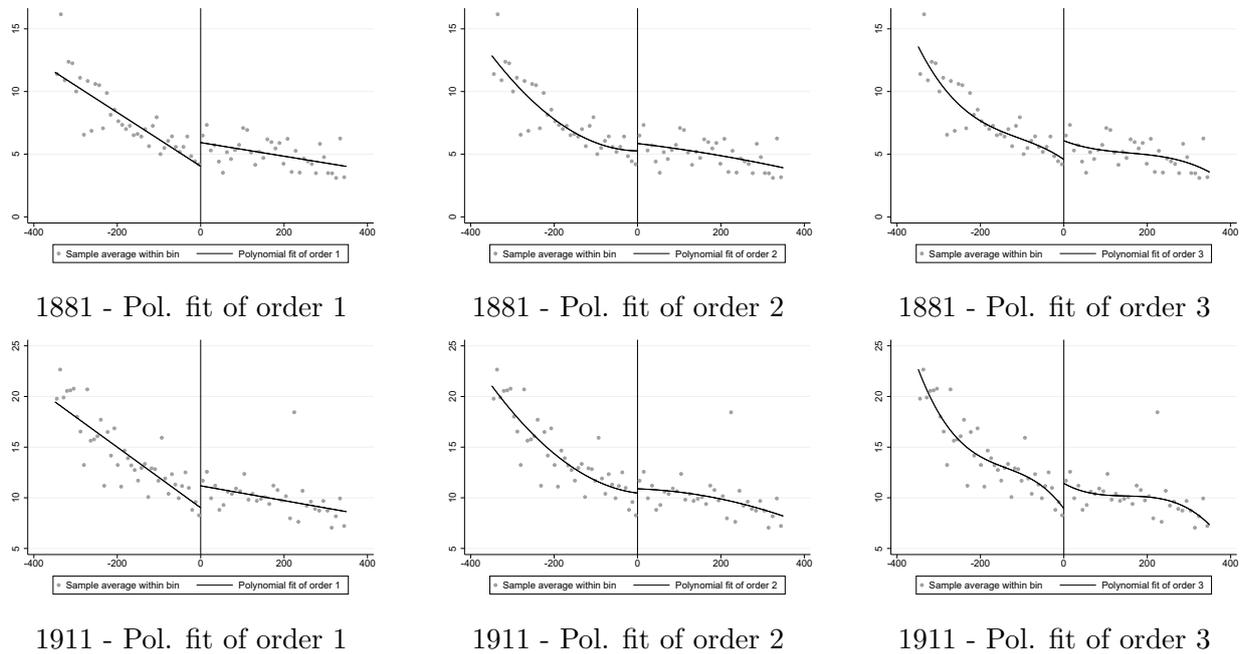


Figure 3.B3: Data-driven regression discontinuity in municipal resources per capita with different polynomial fits

Source: Guizot survey and *La Situation Financière des Communes*.

Notes: On the x-axis, the distance in terms of population to the 500-inhabitant threshold is displayed.

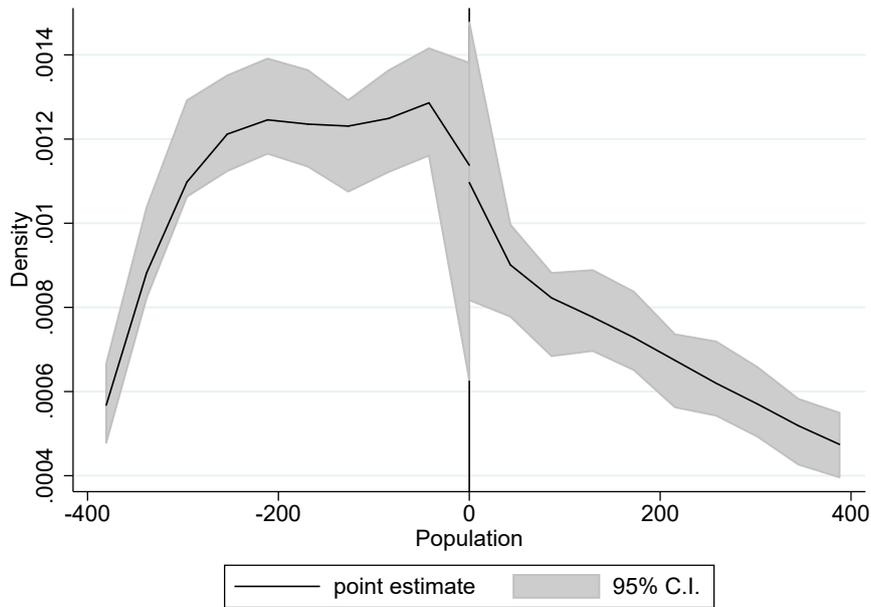


Figure 3.B4: Population density around the 500-inhabitant threshold

Source: (Motte et al., 2003)

Notes: On the x-axis, the distance in terms of population to the 500-inhabitant threshold is displayed. The density of population and its 95% confidence interval are reported in grey.

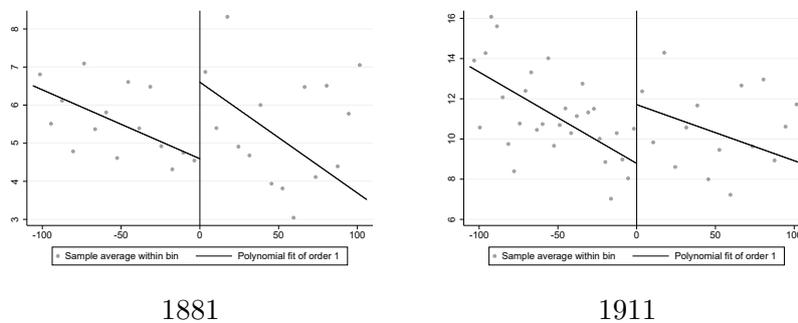


Figure 3.B5: RD plot of treatment effect

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: On the x-axis, the distance in terms of population to the 500-inhabitant threshold is displayed.

Table 3.A2: Non-parametric regression discontinuity estimates with CER-optimal bandwidth - Municipal resources per capita

	1881				1911			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RD Estimate	2.778*** (2.97)	1.856*** (3.14)	2.928*** (3.44)	2.574*** (3.15)	4.115*** (3.23)	2.211*** (2.62)	2.605*** (2.90)	2.107** (2.07)
Controls	253	333	141	197	221	285	237	309
Treated Units	209	245	135	163	187	212	197	228
Covariates	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Left Clusters				67				72
Right Clusters				62				66
Kernel	Triangular	Triangular						
Order Loc. Poly.	1	1	1	1	1	1	1	1
Order Bias	2	2	2	2	2	2	2	2
BW Loc. Poly.	70.91	105.9	49.57	65.67	60.46	90.31	79.02	98.17
BW Bias	188.5	188.5	142.4	148.1	170.3	170.3	218.5	219.4

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: The specifications in this table are the same as in Table 3.3. In columns (3) and (7), I add covariates which are incorporated in the computation of the optimal bandwidth. This is not the case in columns (2) and (6) where the covariates are added without entering in the computation of the optimal bandwidth. I cluster standard errors at the district level in columns (4) and (8).

Table 3.A3: Non-parametric regression discontinuity estimates, other bandwidths - Municipal resources per capita

	1881					1911				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RD Estimate	3.059*** (2.77)	2.700*** (2.97)	2.010*** (2.63)	1.702** (2.40)	1.501** (2.32)	4.286*** (3.08)	3.781*** (3.28)	3.167*** (3.00)	2.554*** (2.74)	2.184*** (2.58)
Controls	172	273	400	465	544	172	272	339	464	544
Treated Units	165	223	294	337	402	168	226	260	340	406
Covariates	No	No	No	No	No	No	No	No	No	No
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
Order Loc. Poly.	1	1	1	1	1	1	1	1	1	1
Order Bias	2	2	2	2	2	2	2	2	2	2
BW Loc. Poly.	50	75	105.9	125	150	50	75	90.30	125	150
BW Bias	50	75	105.9	125	150	50	75	90.30	125	150

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: RD estimates on a choice of different bandwidths are displayed.

Table 3.A4: Non-parametric regression discontinuity estimates - Continuity of covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Population dispersion	Surface area	Altitude	Population growth 1793-1836	Distance to post office	Postal taxes	Industrial production	Distance to prefecture	Latitude
RD Estimate	-1.871 (-0.34)	12.73 (0.81)	-58.13 (-1.39)	-12.85 (-1.46)	-0.679 (-0.89)	4.100 (0.46)	11.47 (1.42)	-3.110 (-1.18)	-0.177 (-0.66)
Controls	405	411	411	419	425	433	433	411	382
Treated Units	285	301	301	305	293	310	310	301	279
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
Order Loc. Poly.	1	1	1	1	1	1	1	1	1
Order Bias	2	2	2	2	2	2	2	2	2
BW Loc. Poly.	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9
BW Bias	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9	105.9

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: RD estimates on covariates are displayed in order to check for the continuity around the 500-inhabitant population threshold.

Table 3.A5: Non-parametric regression discontinuity estimates - Falsification tests

Municipal resources per capita - 1881										
Population cutoffs:	200	300	450	550	700	800	1 000	1 300	1 600	1 900
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
RD Estimate	-2.214 (-1.57)	-0.646 (-0.64)	0.312 (0.45)	-0.373 (-0.60)	-0.655 (-0.80)	0.196 (0.32)	0.364 (0.59)	0.418 (0.55)	-0.224 (-0.41)	-0.223 (-0.47)
Controls	225	365	415	418	448	426	388	300	131	57
Treated units	349	394	375	289	324	296	253	144	69	57
Covariates	No	No	No	No	No	No	No	No	No	No
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
Order Loc. Poly.	1	1	1	1	1	1	1	1	1	1
Order Bias	2	2	2	2	2	2	2	2	2	2
BW Loc. Poly.	96.07	104.1	113.2	120.1	180.7	198.9	247.7	308.1	285.8	252.1
BW Bias	133.1	149.0	172.7	206.4	278.0	318.1	362.0	446.8	462.5	439.8

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: RD estimates on different population thresholds are displayed.

Instrumental variable estimations

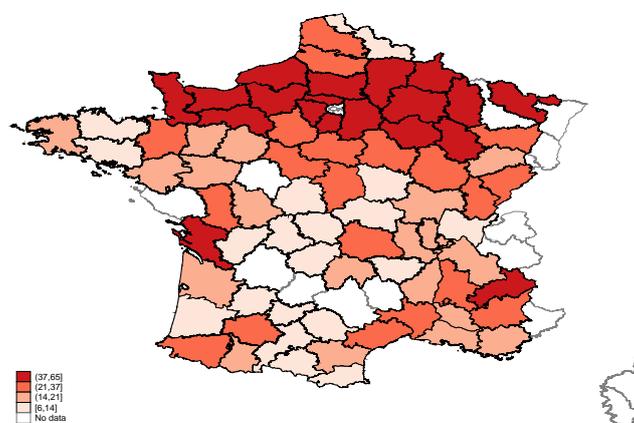


Figure 3.B6: Literacy of men, 1686-1690

Source: *Statistique générale de la France*

Notes: Literacy is measure as the proportion of men who could sign their marriage contract.

Table 3.A6: Printing press and literacy in 1686-1690 at the department level

	(1)	(2)	(3)	(4)	(5)	(6)
	Men	Women	Spouses	Men	Women	Spouses
Printing presses within 150kms	1.731** (2.538)	0.975*** (2.926)	1.336*** (2.696)	–	–	–
Distance to printing press (Kms)	–	–	–	-0.052 (-0.760)	-0.010 (-0.281)	-0.027 (-0.543)
Surface area	0.000 (0.227)	0.000 (0.614)	0.000 (0.325)	0.000 (0.326)	0.000 (0.433)	0.000 (0.310)
Altitude	-0.005 (-0.729)	-0.003 (-0.950)	-0.004 (-0.837)	0.000 (0.015)	-0.001 (-0.163)	-0.000 (-0.078)
Dep. with printing press	-0.226 (-0.063)	-0.636 (-0.364)	-0.382 (-0.147)	-1.993 (-0.316)	-0.139 (-0.044)	-0.768 (-0.166)
Observations	75	75	75	75	75	75
R^2	0.088	0.113	0.098	0.013	0.006	0.008

Source: IGN data, *Statistique générale de la France*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: The unit of analysis is the department. Literacy is measured as the percentage of people who could sign their marriage contract. The administrative centre of departments, the *préfecture*, was taken as the point from which distances were measured for each unit of analysis.

Table 3.A7: Printing press, postal taxes and industrial production

	Postal taxes		Industrial production	
	(1)	(2)	(3)	(4)
Printing presses within 100kms	0.978 (0.118)	–	-0.739 (-0.237)	–
Distance to printing press (Kms)	–	-0.558 (-1.485)	–	-0.168 (-1.129)
Population	0.329*** (3.292)	0.331*** (3.315)	0.031*** (3.836)	0.031*** (3.847)
Population dispersion	-1.694*** (-4.440)	-1.594*** (-4.363)	-0.359** (-2.498)	-0.326** (-2.207)
Surface area	-0.474 (-1.648)	-0.472* (-1.689)	-0.057** (-2.016)	-0.055* (-1.856)
Altitude	0.046 (0.787)	0.043 (0.755)	0.010 (0.551)	0.008 (0.435)
Latitude	2.577 (0.455)	3.947 (0.705)	2.849 (0.811)	3.163 (0.957)
Dep. with printing press	3.045 (0.163)	-19.344 (-0.852)	-15.050 (-1.171)	-23.530* (-1.830)
Observations	6221	6221	6221	6221
R^2	0.194	0.195	0.021	0.022
Clusters	91	91	91	91

Source: Postal and industrial surveys, IGN data, (Motte et al., 2003), (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year.

Table 3.A8: OLS and IV estimations - Schooling years, enrolment and municipal resources

Population intervals	Log of municipal resources, francs per capita - 1881							
			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.050*** (4.636)	0.245*** (3.353)	-	-	-	-	-	-
Log of enrolment	-	-	0.125*** (4.461)	0.671*** (2.847)	0.140*** (4.982)	0.665*** (3.290)	0.282*** (7.809)	0.858*** (3.556)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Distance to printing press		-0.020*** (-18.17)		-0.008*** (-12.58)		-0.007*** (-14.67)		-0.004*** (-6.18)
Observations	5479	5479	4409	4409	5176	5176	1126	1126
R^2	0.581	0.221	0.581	0.245	0.590	0.240	0.564	0.249
$F - stat$		17.964		11.415		14.181		5.623
Regression-based p-value		0.000		0.001		0.000		0.013
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A9: OLS and IV estimations - Schooling years, enrolment and municipal resources

Population intervals	Log of municipal resources, francs per capita - 1911							
			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.042*** (5.162)	0.098** (2.454)	–	–	–	–	–	–
Log of enrolment	–	–	0.104*** (5.165)	0.234** (2.519)	0.115*** (5.777)	0.253*** (2.810)	0.226*** (7.787)	0.395*** (3.108)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.626*** (18.28)		0.228*** (14.60)		0.231*** (17.19)		0.178*** (9.74)
Observations	5472	5472	4405	4405	5170	5170	1123	1123
R^2	0.589	0.243	0.584	0.264	0.600	0.262	0.569	0.282
$F - stat$		21.249		12.052		16.108		29.769
Regression-based p-value		0.108		0.131		0.099		0.184
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A10: OLS and IV estimations - Subjects taught and municipal resources

Population intervals	Log of municipal resources, francs per capita - 1881				Log of municipal resources, francs per capita - 1911			
			Bottom 75%				Bottom 75%	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of subjects	0.054*** (5.542)	0.213*** (3.143)	0.064*** (6.211)	0.216*** (3.244)	0.046*** (6.765)	0.133*** (2.790)	0.054*** (7.942)	0.139*** (3.073)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.471*** (16.01)		0.456*** (14.89)		0.469*** (15.95)		0.453*** (14.81)
Observations	5092	5092	4742	4742	5087	5087	4738	4738
R^2	0.580	0.160	0.594	0.180	0.584	0.159	0.601	0.180
$F - stat$		17.017		14.163		16.925		14.045
Regression-based p-value		0.011		0.011		0.067		0.057
Clusters	85	85	85	85	85	85	85	85

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A11: OLS and IV estimations - Schooling years, enrolment and municipal resources. Robustness check on outliers

Log of municipal resources, francs per capita - 1881								
Municipalities more than 13kms and less than 133kms away from the printing press								
Population intervals			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.046*** (4.241)	0.126** (2.251)	-	-	-	-	-	-
Log of enrolment	-	-	0.118*** (4.219)	0.296** (2.214)	0.131*** (4.596)	0.313** (2.450)	0.281*** (7.592)	0.562*** (3.673)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.596*** (16.19)		0.216*** (13.37)		0.222*** (15.74)		0.192*** (9.61)
Observations	5076	5076	4165	4165	4839	4839	959	959
R^2	0.579	0.239	0.590	0.266	0.593	0.263	0.550	0.276
$F - stat$		16.795		10.397		13.869		34.524
Regression-based p-value		0.095		0.140		0.112		0.041
Clusters	81	81	78	78	81	81	77	77

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres. Only municipalities more than 13 kilometres and less than 133 kilometres away from printing presses are taken into account. This amounts to excluding the top 5% and the bottom 5% in terms of distance to the printing press.

Table 3.A12: OLS and IV estimations - Schooling years, enrolment and municipal resources. Robustness check on municipalities close to the printing press

Log of municipal resources, francs per capita - 1881								
Municipalities more than 35kms away from the printing press								
Population intervals			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	0.057*** (5.020)	0.178*** (2.697)	–	–	–	–	–	–
Log of enrolment	–	–	0.140*** (4.856)	0.387*** (2.742)	0.155*** (5.283)	0.403*** (2.986)	0.289*** (7.334)	0.651*** (3.899)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.629*** (15.26)		0.252*** (13.55)		0.255*** (16.08)		0.182*** (8.20)
Observations	4295	4295	3405	3405	4030	4030	925	925
R^2	0.576	0.293	0.584	0.341	0.589	0.332	0.576	0.305
$F - stat$		16.552		14.912		18.387		21.315
Regression-based p-value		0.011		0.022		0.017		0.009
Clusters	81	81	79	79	81	81	72	72

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres. Only municipalities more than 35 kilometres away from printing presses are taken into account. This amounts to excluding the bottom 25% in terms of distance to the printing press.

Table 3.A13: IV estimations - Schooling years, enrolment and municipal resources. Robustness check: alternative radii for the number of printing presses

Population intervals	Log of municipal resources, francs per capita - 1881							
			Bottom 75%		Bottom 90%		Top 25%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Schooling Years	0.147*** (2.797)	0.161*** (2.978)	-	-	-	-	-	-
Log of enrolment	-	-	0.372*** (2.748)	0.416** (2.389)	0.384*** (2.964)	0.466*** (2.961)	0.481*** (3.035)	0.786*** (4.955)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 75kms	0.843*** (17.15)		0.319*** (14.65)		0.316*** (16.45)		0.238*** (8.40)	
Printing presses within 150kms		0.461*** (22.45)		0.153*** (15.21)		0.158*** (18.91)		0.133*** (11.53)
Observations	5479	5479	4409	4409	5176	5176	1126	1126
R^2	0.237	0.274	0.264	0.273	0.258	0.277	0.276	0.329
$F - stat$	18.315	23.902	12.679	10.564	15.136	15.604	21.090	34.359
Regression-based p-value	0.019	0.020	0.017	0.053	0.016	0.015	0.155	0.000
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A14: OLS and IV estimations - Schooling years and municipal resources. Robustness check on different population intervals

Population intervals	Log of municipal resources, francs per capita - 1881									
	Bottom 75%			Bottom 90%			Top 25%			
	OLS (1)	IV (2)	IV (3)	OLS (4)	IV (5)	IV (6)	OLS (7)	IV (8)	IV (9)	
Schooling Years	0.049*** (4.045)	0.163*** (2.663)	0.251*** (2.937)	0.054*** (4.726)	0.158*** (3.010)	0.235*** (3.471)	0.082*** (6.815)	0.192*** (3.830)	0.265*** (3.373)	
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
First-stage, dependent variable is:			Schooling years							
Printing presses within 100kms		0.557*** (15.05)			0.609*** (18.71)			0.616*** (11.32)		
Distance to printing press			-0.021*** (-14.92)			-0.022*** (-18.16)			-0.012*** (-7.22)	
Observations	4373	4373	4373	5126	5126	5126	1106	1106	1106	
R^2	0.582	0.264	0.252	0.592	0.258	0.241	0.555	0.278	0.228	
$F - stat$		12.280	13.658		18.638	18.742		33.225	7.322	
Regression-based p-value		0.022	0.001		0.017	0.000		0.009	0.016	
Clusters	83	83	83	85	85	85	81	81	81	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A15: GMM estimations - Schooling years, enrolment and municipal resources. Robustness check accounting for spatial autocorrelation. Bottom 75% of the population

Dependent variable: Log of municipal resources, francs per capita - 1881								
Spatial standard errors:	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Schooling Years	0.163*** (0.016) [0.041]		0.163*** (0.016) [0.059]		0.163** (0.016) [0.067]		0.163** (0.016) [0.071]	
Log of enrolment		0.396*** (0.038) [0.093]		0.396*** (0.038) [0.132]		0.396*** (0.038) [0.152]		0.396** (0.038) [0.162]
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4373	4362	4373	4362	4373	4362	4373	4362

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: The spatial GMM estimations rely on the number of printing presses within 100 kilometres as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 3.A16: GMM estimations - Schooling years, enrolment and municipal resources. Robustness check accounting for spatial autocorrelation. Top 25% of the population

Dependent variable: Log of municipal resources, francs per capita - 1881								
Spatial standard errors:	25 km radius		50 km radius		75 km radius		100 km radius	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Schooling Years	0.191*** (0.026) [0.035]		0.191*** (0.026) [0.045]		0.191*** (0.026) [0.050]		0.191*** (0.026) [0.053]	
Log of enrolment		0.659*** (0.090) [0.118]		0.659*** (0.090) [0.152]		0.659*** (0.090) [0.171]		0.659*** (0.090) [0.183]
Demographic controls	Yes							
Economic controls	Yes							
Distance controls	Yes							
Observations	1104	1104	1104	1104	1104	1104	1104	1104

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: The spatial GMM estimations rely on the number of printing presses within 100 kilometres as an instrument. Conley standard errors corrected for spatial autocorrelation (Conley, 1999) are reported in square brackets. Regular standard errors are reported in brackets. The spatial correlation in error terms is considered as linearly declining along a 25, 50, 75 or 100 radius from each observation.

Table 3.A17: OLS estimations - Schooling year, enrolment and municipal resources within departments. Positive or negative spillovers on municipalities without schools

Log of municipal resources, francs per capita - 1881												
	Deps. with % municipalities with schools < median						Deps. with % municipalities with schools > median					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Distance to school (kms)	0.001*** (2.807)	-	-	0.004*** (4.192)	-	-	0.005*** (4.866)	-	-	0.000 (0.098)	-	-
Nb of schools - 50 kms	-	0.000 (0.226)	-	-	-0.000 (-0.700)	-	-	-0.002*** (-5.965)	-	-	-0.001*** (-3.158)	-
Log of enrolment - 50 kms	-	-	1.421*** (6.336)	-	-	0.064 (0.196)	-	-	-0.882*** (-6.244)	-	-	-0.464*** (-2.898)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Department fixed effects	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes
Observations	1530	1530	1530	1530	1530	1530	905	905	905	905	905	905
R ²	0.372	0.369	0.386	0.704	0.702	0.701	0.653	0.655	0.656	0.709	0.712	0.711

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres. Departments below the media level are: Cher, Corrèze, Cotes d'Armor, Finistère, Indre, Indre et Loire, Loire Atlantique, Lozère, Morbihan, Nièvre and Saône et Loire. Departments above the median level are: Ardèche, Ardennes, Gard, Gers, Loiret, Marne, Oise, Seine et Marne, Deux Sèvres and Vaucluse. Only municipalities without schools are taken into account in the estimations. *Nb of schools* refers to the number of schools within 50 kilometres around each municipality with no school. *Log of enrolment* refers to the average enrolment within municipalities around those with no schools. This measure is also limited to a 50 kilometres area.

Schooling quality and development

Table 3.A18: Public subsidies and municipal resources, francs per capita

Resources per capita:	1881					1911				
	No subsidy		Subsidy		p-value	No subsidy		Subsidy		p-value
	N	Mean	N	Mean		N	Mean	N	Mean	
Fixed salary	1570	5.83	2670	10.01	0.000	1575	11.22	2670	16.91	0.000
High salary	905	7.95	1815	11.28	0.000	906	13.82	1812	18.77	0.000
Accommodation, classroom	1999	7.18	2241	9.61	0.000	2001	13.29	2244	16.14	0.000
Other occupation	1810	6.54	2276	10.03	0.000	1814	11.71	2275	17.26	0.000
2nd degree certificate	2648	7.80	1592	9.58	0.000	2650	14.04	1595	16.06	0.000

Source: Guizot survey and *La Situation Financière des Communes*.

Notes: There are 1570 municipalities with a primary school in the data which didn't provide a fixed salary to the teacher. The average level of resources per capita of these municipalities was around 5.83 francs in 1881. The respective figures for municipalities paying teachers on a fixed basis are 2670 and 10.01 francs per capita. The difference between the two is significant at a one-percent level. The *High salary*, variable is equal to one if the municipality was paying the teacher more than 200 francs per year, which is the median fixed salary level.

Table 3.A19: Covariates balance test on matched sample

	1881					1911				
	Sample mean		Percent bias	Percent reduction	t-statistic (p-value)	Sample mean		Percent bias	Percent reduction	t-statistic (p-value)
	Treated	Control				Treated	Control			
Log of enrolment	2.16	2.1461	1.8	97.4	0.60 (0.548)	2.1593	2.1408	2.4	96.5	0.80 (0.424)
Schooling years	5.6299	5.6033	1.4	97.5	0.46 (0.649)	5.627	5.6049	1.2	97.9	0.38 (0.706)
Population - 1833	789.12	821.33	-4.1	71.9	-1.36 (0.174)	788.43	824.5	-4.6	68.6	-1.52 (0.128)
Population dispersion	35.998	35.471	1.6	96.6	0.50 (0.617)	36.025	35.658	1.1	97.6	0.35 (0.728)
Surface area	147.54	145.01	2.0	91.8	0.68 (0.499)	147.49	144.66	2.2	90.9	0.75 (0.451)
Printing presses (100kms)	2.3668	2.4041	-2.7	72.6	-0.89 (0.374)	2.3697	2.3955	-1.9	81.6	-0.61 (0.541)
Distance to post office	6.555	6.7669	-4.7	55.3	-1.50 (0.134)	6.5621	6.7631	-4.5	56.9	-1.42 (0.155)
Postal taxes	154.03	169.92	-2.7	67.3	-1.63 (0.104)	153.99	170.17	-2.8	66.8	-1.66 (0.098)
Industrial taxes	51.244	46.989	1.7	82.9	0.53 (0.599)	51.468	54.383	-1.1	87.9	-0.35 (0.726)
Distance to economic centers	118.85	116.42	4.4	68.3	1.41 (0.160)	118.88	117.25	3.0	78.8	0.94 (0.345)

Source: Guizot, industrial, postal surveys, IGN data. (Motte et al., 2003) and *La Situation Financière des Communes*.

Notes: When using the matching technique for the year 1881, the average log of enrolment in the treated group is around 2.16, around 2.1461 in the control group. The bias associated corresponds to the difference between the expected enrolment in the treated group and the expected enrolment in the control matched group (Rosenbaum and Rubin, 1985). It is reduced of 97.4% compared to the difference between the expected enrolment in the treated group and the expected enrolment in the control group without matching. The t-test p-value indicates that the difference in enrolment between matched treated and control groups is not significant.

Table 3.A20: Matching estimations - Public subsidies and log of municipal resources, francs per capita

	Nearest-neighbor, common support, caliper of 0.2 std. of propensity score							
	1881				1911			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fixed salary	0.185*** (7.497)	-	-	-	0.135*** (7.070)	-	-	-
High salary	-	0.127*** (4.434)	-	-	-	0.097*** (4.375)	-	-
Accommodation, classroom	-	-	0.023 (0.814)	-	-	-	0.048** (2.282)	-
Other occupation	-	-	-	0.097*** (3.617)	-	-	-	0.077*** (3.720)
Observations	3960	2698	3262	3596	3960	2694	3260	3594

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys, IGN data. (Motte et al., 2003) and *La Situation Financière des Communes*.
Notes: All variables are dummy ones, indicating if the municipality at stake was subsidising primary education. The *High salary*, variable is equal to one if the municipality was paying the teacher more than 200 francs per year, which is the median fixed salary level.

Table 3.A21: OLS and IV estimations - Schooling years, enrolment and growth of municipal resources

Population intervals	Growth municipal resources, francs per capita - 1881-1911							
			Bottom 75%		Bottom 90%		Top 25%	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Schooling Years	-2.129* (-1.813)	-15.356** (-2.237)	-	-	-	-	-	-
Log of enrolment	-	-	-5.189* (-1.886)	-39.715** (-2.071)	-6.046** (-2.074)	-39.711** (-2.173)	-14.381*** (-2.749)	-61.319** (-2.573)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
First-stage, dependent variable is:	Schooling years				Enrolment rate			
Printing presses within 100kms		0.510*** (13.61)		0.191*** (11.41)		0.195*** (13.16)		0.168*** (7.76)
Observations	5409	5409	4358	4358	5111	5111	1107	1107
R^2	0.158	0.241	0.171	0.262	0.159	0.260	0.125	0.285
$F - stat$		21.099		12.046		16.145		30.353
Regression-based p-value		0.017		0.026		0.025		0.018
Clusters	85	85	83	83	85	85	81	81

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial, postal surveys and IGN data. (Motte et al., 2003), *La Situation Financière des Communes*, (ISTC, 1998) and (Febvre and Martin, 1999).

Notes: Population dispersion is measured in percentage, the surface area in tens of hectares and altitude in meters. Postal taxes are in francs, the industrial production in thousands of francs per year. All distances are reported in kilometres.

Table 3.A22: OLS estimations - Primary schooling and industrial wages

Industrial:	Male wages			Female wages			Child wages		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Primary School	11.946*	–	–	-1.499	–	–	7.073	–	–
	(1.766)			(-0.298)			(1.577)		
Log of enrolment	–	5.041*	–	–	-0.249	–	–	3.579	–
		(1.801)			(-0.110)			(1.643)	
Schooling Years	–	–	2.923***	–	–	0.350	–	–	1.399
			(2.684)			(0.463)			(1.599)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	559	552	545	247	246	241	281	278	273
R^2	0.244	0.243	0.249	0.201	0.200	0.198	0.122	0.123	0.125
Clusters	79	79	78	62	62	61	68	68	67

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Guizot, industrial and postal surveys. IGN data, (Motte et al., 2003).

Notes: *Primary School* stands for the presence of a primary school in the municipality at stake. All industrial wages are computed at the average wages at the municipality level.