CESifo WORKING PAPERS

9997 2022

October 2022

Taxation with a Grain of Salt: The Long-Term Effect of Fiscal Policy on Local Development

Tommaso Giommoni, Gabriel Loumeau

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 9997*

Taxation with a Grain of Salt: The Long-Term Effect of Fiscal Policy on Local Development

Abstract

This paper studies the long-term effect of taxation on economic geography and development. We rely on a unique natural experiment in place during France's *ancien régime*: the salt tax. Introduced in the late 13th century and abrogated by the French Revolution in 1789, the salt tax was not uniformly levied across the French kingdom as its rate varied discontinuously in space. Using a series of rich and original historical data at regular time intervals and very fine spatial resolution since the fifteen century, we estimate a Spatial RDD model. We find that these exogenous tax rate differentials have had large effects on economic geography and development. These effects are, then, confirmed in a DiD analysis, that studies a very large time span (1400-1900 using regular intervals of 25 years) and documents the absence of pre-trends. Most of the effects can still be observed today in population density, firm density, and local average income.

JEL-Codes: H200, N330, O230, J610.

Keywords: taxation, long-term, economic georgraphy, development, spatial discontinuity, salt tax.

Tommaso Giommoni
Department of Management, Technology, and Economics, ETH Zürich
Leonhardstrasse 21
Switzerland – 8092 Zurich
giommoni@ethz.ch

*Gabriel Loumeau**
Department of Management, Technology, and Economics, ETH Zürich
Leonhardstrasse 21
Switzerland – 8092 Zurich
loumeau@ethz.ch

*corresponding author

September 30, 2022
We are particularly grateful to workshop participants in Fribourg, Mannheim, Munich, Rennes and Zurich. In particular, we thank (in alphabetical order) Achim Ahrens, Sergio Galletta, Gloria Gennaro, Marko Koethenbuerger, Andreas Peichl, Marco Tabellini and Jing Xing for helpful comments and suggestions. We are also very thankful to Leonard Dauphant and Mireille Touzery for invaluable discussions on the fiscal system in place during the *Ancien Régime*.

1 Introduction

The way tax systems are designed has pervasive consequences on the economy, demography and society as a whole (Slemrod, Gillitzer, et al., 2014). The literature has extensively studied the short-run impacts of taxation on socio-economic outcomes.[1] Yet, despite an important theoretical literature (King and Rebelo, 1990; Jones, Manuelli, and Rossi, 1993; Stokey and Rebelo, 1995; and Zagler and Dürnecker, 2003 for a review), we have little causal evidence on the long-run effects of fiscal policy on development, and even less on whether these effects persist even after fiscal policies have changed. Hence, similarly to other historical institutions (Acemoglu, Johnson, and Robinson, 2001; Glaeser and Shleifer, 2002; Michalopoulos and Papaioannou, 2013; Squicciarini and Voigtländer, 2015), do the effects of fiscal policy on local development persist in the long-run?

In this paper, we aim to fill this gap in the literature, studying the (very) long-term impact of taxation on development. To do so, we rely on a unique natural experiment that took place during the *Ancien Régime*, and we leverage on a series of rich and original historical data. The object of our analysis is the salt tax in France, the *Gabelle du sel*, a very important tax that remained in force for more than five hundred years.[2] The *Gabelle* has been introduced for the first time at the end of the thirteen century and, despite medievalists still debate on this, most historians agree that Philip IV, the Handsome, was the first king to levy such an impost. The tax remained in force for many centuries and it underwent several modifications until the abrogation, during the French revolution in 1789. This tax was very important for the royal treasury and it was greatly unpopular. It was highly expensive for the people, and collecting methods were many times vexatious.

An important peculiarity of the *Gabelle* was that the tax rate was not uniform over the territory of the French kingdom, but there were large differences across areas, introduced over time for specific historical reasons. These differences create wide discontinuities in tax rate over the French territory. The large region around Paris, known as the *pays de grandes gabelles*, was subject to a very high tax rate of around 60

[1]See Alinaghi and Reed, 2021 for a review.

[2]The historical information on the salt tax are based on Sands and Higby (1949), if not differently specified.

pound per *minot*, with small differences across departments.[3] Differently, there were special areas that benefited from a favorable tax rate: part of the Normandy (*Quart bouillon*) was subject to a reduced rate of 13, the south-western part of France (*Pays rédimées*) benefited from a 10 rate and the regions of Alsace and Lorraine, (*Pays de salines*), faced a 15 tax rate.[4] Figure 1 shows the map of the *Gabelle* and it highlights the areas of interest: *pays de grandes gabelles* (the white central area) and the three areas with a lower tax rate (*Quart bouillon* – yellow area in the north-west; *Pays rédimées* – green area in the south-west; *Pays de salines* – the eastern area including the Alsace, Lorraine and Franche Comté). At these salt tax borders, the provision of public goods did not differ.[5]

This setting represents a unique natural experiment to study the causal effect of taxes in the (very) long-term. Indeed, the borders between the *pays de grandes gabelles* and the other areas create exogenous discontinuities in the tax rate, and allow us to analyse the impact of such large gaps on a series of economic and demographic indicators, immediately after the abolition of the tax –in the 18th century– and in the long-term –today–. In particular, we estimate a spatial Regression-Discontinuity-Design (RDD) model, in which the distance to the salt-tax borders between the *pays de grandes gabelles* and the three favorable areas represents our forcing variable. Importantly, historical evidence suggest that the exact borders between the *pays de grandes gabelles* and the other areas have been designed in a plausibly exogenous manner, as they did not coincide with old administrative and historical boundaries, such as those of departments and dioceses. This makes unlikely that these borders capture additional policy variations. Moreover, we provide evidence that characteristics are balanced around the tax borders, with reference to geographical features such as soil fertility, distance to the nearest river and altitude, as well as historical infrastructures, as the network of roman roads.

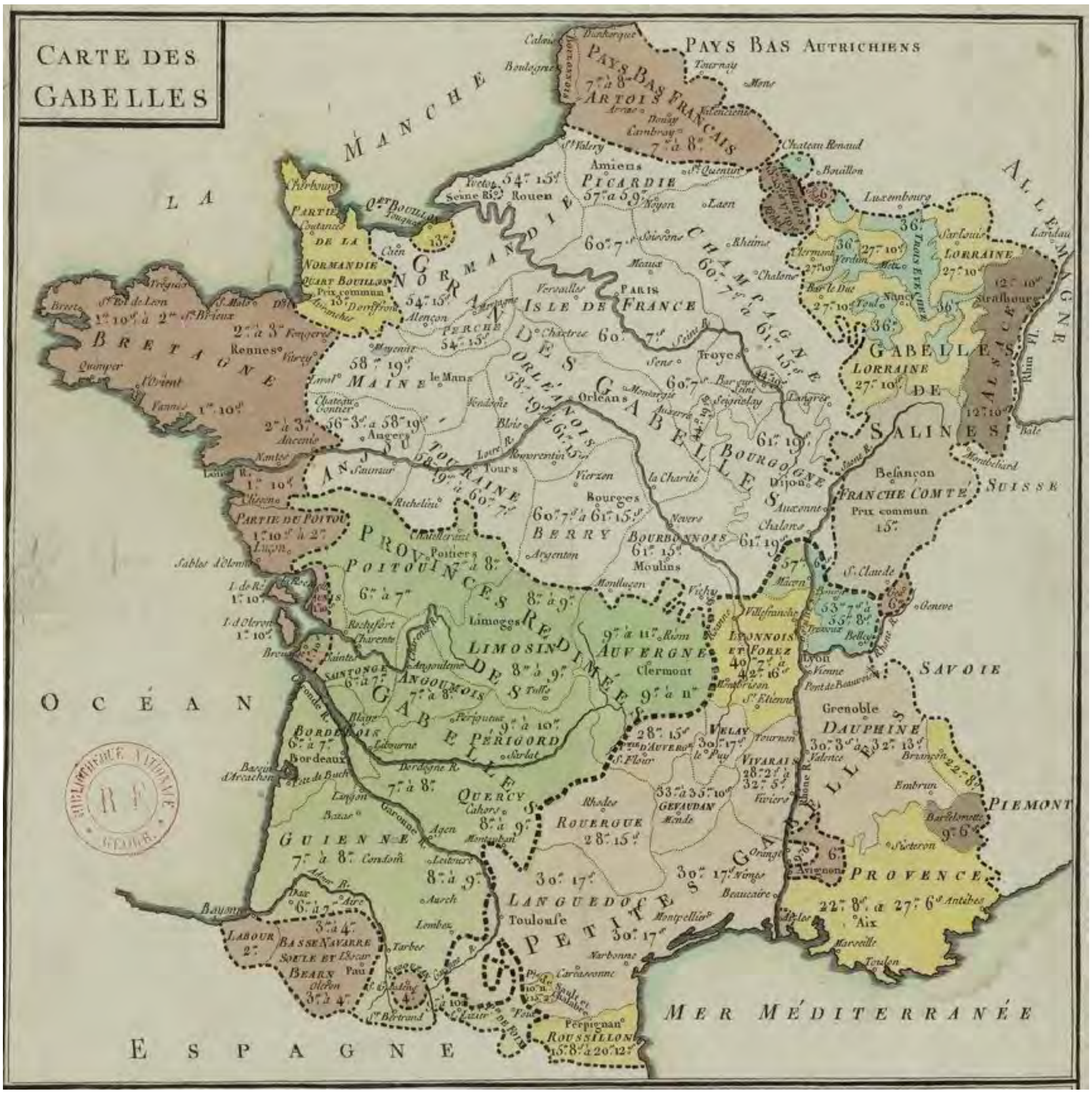
To conduct those analyses we rely on a rich set of original historical data. First, we have access to detailed data on population and other demographic indicators at the

[3] A *minot* is an old French measure of volume, corresponding to about 40 liters.

[4] It is important to mention that there were other tax regions in France, subject to special fiscal conditions. We are not studying these areas as in those cases the borders identify other policy variations, being old administrative divisions.

[5] In the *Ancien Régime*, the public goods provided were minimal and centered around royal prerogatives such as national defense, issuing money, justice, etc.

Figure 1: Salt Taxation during the *Ancien Régime*



Source: National Library of France, BnF. Map includes the tax rates in place at the end of the *Ancien Régime*.

municipal and arrondissement level covering the 18th, 19th and 20th centuries. The earliest population figure that we are able to study dates back to the 1789. Second, we have rich demographic and economic current data, aggregated either at the municipal level or with a more fine-grained aggregation of 1 km^2 cells.

The main results suggest that this difference in tax systems have had large effects on economic geography and development, both in the short- and long-term. First, we focus on the effects in the long-term, i.e more than two centuries after the tax abrogation. We document that municipalities located in the areas with a favorable tax rate, the "Low Tax Area" (hereafter "LTA"), have a larger population density today, compared to those located in the *pays de grandes gabelles*, the "High Tax Area" (hereafter "HTA"). Moreover, cities in LTA are characterized today by better economic indicators, with higher average income and lower fraction of poor households. Second, we focus on the effect in the short-run, i.e. right after the abolition of the *Gabelle*, that took place during the French revolution. With the use of historical data at the municipal and arrondissement level, we show that population density was already larger in the LTA immediately after the abolition of the tax in 1789. Moreover, we are able to study the effect of this tax differential in the following decades, in the 19th and 20th centuries, at regular time intervals. The estimates show that the difference in population density between LTA and HTA persists over time. Overall, these results are among the first to show that taxation may have important consequences in the (very) long-run period, as they suggest that the impact of a tax may persists even two centuries after its abrogation. Moreover, thanks to the short-term analysis, we are able to confirm that the effects observed today, around the salt-tax borders, can be attributed to the *Gabelle* and not to other historical events subsequent to the tax abrogation.

Furthermore, we corroborate these results on population density with an alternative empirical strategy. In particular, we estimate a standard Difference-in-Differences model, comparing population density before and after the introduction of the salt tax around the tax border. To conduct this additional analysis we rely on novel historical micro-data on French population, based on genealogy online portals: the final dataset includes historical information on more than 47 millions individuals that lived between the fifteenth and the twentieth century, allowing us to measure municipal population density for a very large time span.[6] The main results confirm the previous findings: first, municipalities in the LTA show a higher population density after the introduction of the salt tax and, second, there is no significant difference around the border before the institution of the tax, suggesting the absence of pre-trends. These results further confirm the causal effect of the salt tax on local development and support the identification assumptions of the RDD analysis.

Finally, a series of additional analyses corroborate the main results of the paper. First, we estimate an alternative empirical model, following an instrumental vari-

[6] Importantly, in this analysis we cannot study municipalities in the *Quart bouillon* as the introduction of the salt tax in this area took place in 1246, before the beginning of our time series on municipal population density.

able approach. We exploit the fact that, despite the exact location of the tax borders is plausibly exogenous, the municipalities in the LTA are usually characterized by a favourable access to the production sites of salt. We instrument, therefore, the treatment status, i.e. being in the LTA, with the distance to salt marshes and underground salt mines, and the main results are confirmed. Second, we conduct a series of placebo tests, estimating the main spatial RDD model on a fake spatial border, which is permuted from -40km to +40km. The main results show no effects around these placebo lines. This test reassures that the salt-tax border is not capturing other spatial features.

To rationalize the effects observed, we empirically test two (complementary) mechanisms. First, we study population growth around the salt tax border via two channels: (i) migration from the HTA to the LTA, (ii) increased fertility in the LTA. Using migration data at the individual level between 1400 and 1900, we show that the LTA experienced a significant population in-flow following the introduction of the salt tax. Moreover, studying the heterogeneity in population dynamics by age, we provide evidence that fertility increased relatively in the LTA following the Gabelle. Second, we discuss how higher population growth may have led to higher economic productivity, and show that sorting of economic activity has likely induced economic gains for the LTA. Finally, we also consider other channels which may have played a role in generating the observed discontinuities, but that are unlikely to be prime determinants (i.e., changes in attitudes and institutions, and salt smuggling).[7]

Related literature. Our paper is closely related to the literature analyzing the long-term impact of economic institutions on development and economic geography. Dell (2010) studies the *mita*, a forced mining labor system in force in Peru and Bolivia between the 16th and 19th century, showing that the areas subject to this system have lower household consumption and higher levels of malnutrition. A related study is Markevich and Zhuravskaya (2018), showing that the abolition of serfdom in 1861 led to substantial increase in agricultural productivity, industrial output and peas-

[7]For instance, the effect of the salt tax appears already within a few years. This renders changes in economic attitudes and institutions – which are generally slow processes – unlikely mechanisms. Similarly, historical estimates on the number of families involved in salt smuggling renders this channel unlikely to explain the lion's share of the effect.

ants' nutrition in Imperial Russia. Moreover, Franco, Galiani, and Lavado (2021) study the Inca road, an extensive transportation system created during the Inca Empire, and document long-term effects including higher wages and educational attainment. Juhász (2018) shows that the temporary introduction of trade protection in Napoleonic France improved industrial technology adoption, with a subsequent increase in industrial value-added (per capita) up to the 19th century. Moreover, there is evidence on how long-term economic growth could be fostered by early technology adoption (Juhász, Squicciarini, and Voigtländer, 2020), initial human capital accumulation (Squicciarini and Voigtländer, 2015), old migration inflows (Burchardi, Chaney, Hassan, Tarquinio, and Terry, 2020), as well as original city political relevance (Bai and Jia, 2020).[8] Thanks to its unique historical setting, our paper is among the first to study the long-term effect of taxation on development and economic geography. Moreover, we leverage on a rich set of historical data to track the effect of the *Gabelle* over time – and at regular intervals – starting in 1400 (before the introduction of the tax) and until today (after its abolition by the French Revolution).

Moreover, the long-term natural experiment presented in this paper brings novel insights to the economic geography literature on spatial persistence and path dependency.[9] This paper offers an empirical counterpart – based on a very mild set of assumptions – to the theoretical and structural study of persistence and path-dependency in geographic settings (Krugman, 1991; Matsuyama, 1991; Rauch, 1993; Herrendorf, Valentinyi, and Waldmann, 2000; Ottaviano, 2001; Allen and Donaldson, 2020; Kleinman, Liu, and Redding, 2021). It is clear that a *stable long term level effect* – as revealed in this paper – can only take place under strict conditions on parameters linking time periods with each other. Beyond spatial persistence and path-dependency, the quasi-experimental findings in this paper indicate that – absent specific policies – regional convergence is not mechanic *even very locally* (on regional convergence, or the lack thereof, see Barro and Sala-i Martin, 1992; Kim, 1995; Mitch-

[8]Furthermore, an extensive literature focuses on the long-term impact of historical shocks, such as wars or epidemics, on subsequent economic outcomes (e.g. Becker, Grosfeld, Grosjean, Voigtlander, and Zhuravskaya, 2020; Fouka and Voth, 2016; Galletta and Giommoni, 2020).

[9]Seminal empirical work on persistence and path dependency in a spatial setting include Davis and Weinstein (2002, 2008), as well as Bleakley and Lin (2012, 2015). Allen and Donaldson (2020) define persistence as "the long-lived dependence of current outcomes on temporary events", and path dependence as the case "where temporary events fully govern long-run outcomes".

ener and McLean, 1999; Ganong and Shoag, 2017; Kleinman et al., 2021). Indeed, we observe that a very local discontinuity in income and population may hold over very long time at a stable level.

Our paper also contributes to the large literature on the effects of taxes on development and financial indicators. As mentioned in the introduction, a large theoretical literature has investigated the role of fiscal policy on growth and development in the long-run (see, seminal work, by King and Rebelo, 1990; Jones et al., 1993; Stokey and Rebelo, 1995).[10] This paper provides a novel perspective on this question by studying empirically the causal effect of taxation on development. To do so, we combine state-of-the-art quasi-experimental techniques to a novel municipal-level dataset over seven centuries.

Beyond the general relationship between taxation and development, this paper also provides novel insights on the role of direct taxes on local development over time, as the *Gabelle* is an important (historical) example of value added tax. Direct taxes, and in particular the value added tax (VAT), are among the youngest, yet among the most important sources of government revenue, and, according to the seminal literature, they are efficient tax instrument (Diamond and Mirrlees, 1971). The introduction of the VAT has been found to be associated with an increase in growth and investment, as well as lower inflation and government spending as a share of GDP (Ufier, 2014). Moreover, the VAT is linked to an improvement in public finance, in terms of a reduction in central government debts and deficit (Ufier, 2017), but also to an increase in inequality (Alavuotunki, Haapanen, and Pirttilä, 2019). However, a large literature underlines how the impact of adopting VAT is still limited in less developed countries (Keen and Lockwood, 2010; Ahlerup, Baskaran, and Bigsten, 2015; Adhikari, 2020). Thanks to the natural experiment of the *Gabelle*, we are among the first to study the impact of the VAT in the (very) long-run on development and economic growth.

The paper is organized as follows. Section 2 presents the historical background and Section 3 describes the data. Section 4 discusses the empirical strategy and shows the main results. Section 5 studies the main mechanisms. Finally, Section 6 provide some final remarks.

[10] Zagler and Dürnecker (2003) for a review.

2 Salt tax in France (1246-1945): *La Gabelle du Sel*

Salt was in use long before recorded history. Since the dawn of time, animals have instinctively forged trails to natural salt sources to satisfy their need for salt. Regular salt consumption for humans and livestock is a necessity. In humans, salt deprivation can lead to muscle cramps, nausea, vomiting and dizziness. Eventually, lack of salt can lead to shock, coma and death. Animals need salt for growth as well as a healthy, properly functioning body.[11] Beyond health effects, salt has played a key role in food preservation since ancient times. Sodium draws the bacteria-causing moisture out of foods, drying them and making it possible to store meat without refrigeration for extended periods of time. Traditional dishes such as Parma hams, gravlax, bresaola and baccala are all the result of salt curing.

Throughout history, salt has frequently been a source of taxation, such that – since ancient times – it is likely to have been the most taxed commodity. Records of salt taxation can be found in, e.g., the Roman Empire, China, Russia, India, England, and France.

In this section, we present four key facts about the history of salt taxation in France.

Fact 1: A large and unpopular source of royal revenue for 550 years. The *Gabelle du Sel* was first introduced as a temporary source of income in 1246 by Philip IV, the Handsome, to finance crusading ambitions in the Middle-East. The tax became permanent under Charles V in the second half of the 14$^{\text{th}}$ century, and remained so until its abrogation by the French Revolution in 1790.[12] Figure A2 presents the chronology of salt taxation in France.

During almost 550 years, the salt tax was an important source of revenues for the royal treasury. Figure A3 presents the composition of the royal revenues between 1200 and the Revolution. Representing 12% of revenues in its early years, the salt tax

[11]Salt primarily consists of sodium and chloride, but it contains other essential minerals as well such as calcium. In animals, sodium balances the pH levels in the blood, chlorine balances the acid levels in the body and helps digestion, whereas calcium in salt is fundamental for strong bone and teeth development in lactating cows and nursing calves.

[12]Royal ordinances in 1366, 1372 and 1379 shifted the temporary nature of the tax towards a permanent one (Sands and Higby, 1949).

gained importance over time to end up raising 22% of overall royal revenues during the 18th century. This growth is mostly due to the increased economic activity as rates remained relatively stable during that period. The relative increase mostly came at the expense of revenues from the royal domain which relatively stagnated, when the French economy was otherwise growing.

In practice, citizens were assigned to a royal salt storehouse – based on their residential location. Salt storehouses (*grenier à sel*, in French) had a monopoly on salt sales. Citizens were required to buy minimum amounts of salt, and a tax (linearly) proportional to quantity was added to the final price. Salt storehouses were evenly spread across the Kingdom at approximately 10km to 15km intervals, such that the round-trip would always be doable within a day. Figure A4 illustrates the location of the salt storehouses along the Loire river between Tours and Orléans.

Across the centuries, salt taxation was always widely unpopular and judged as unfair. As Sands and Higby (1949) put it:

> *The French salt tax [...] was one of the iniquitous institutions of the Ancien Régime [...]. It is usually described as a most unfair tax that gave rise to conditions comparable to those flourishing in the United States during the Prohibition Era.*

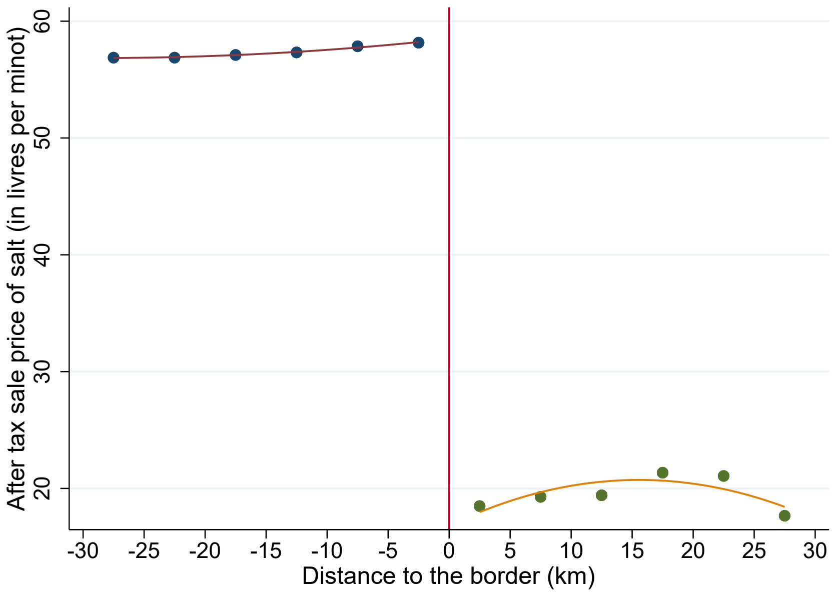
Similarly, Sands and Higby (1949) report an ordinance of Philip V, the Long, dated February 25, 1318, proposing the abolition of the salt tax because *"La gabelle du sel et les impositions de quatre deniers pour livre estoient moult deplaisans à nostre peuple."* [The salt tax and the levy of four coins were very unpleasant for our people.]

Until the French Revolution, the use and the disposal of salt was highly regulated by an extensive regulatory body. Collecting methods of the *Gabelle* were severe and many times vexatious. As stated by Chanel et al. (2015), *"[...] the Fermes générales developed a rigid system of surveillance and coercion backed by drastic penal codes"*.

After the revolution, Napoléon reinstated the salt tax in 1806 with a several major modifications. From 1806 onward, the salt tax rate was spatially uniform and much lower. Moreover, citizens were not forced anymore to buy minimum amounts of salt. Finally, salt taxation in France was abrogated in 1945.

Fact 2: Spatially discontinuous tax rates. Until the French Revolution, the tax rate levied on salt was not uniform across the kingdom, and depended on one's location. All colored zones in Figure 1 corresponded to a different tax rate. In this paper, we focus on the borders to the *Pays de Grandes Gabelles* (Figure 1, the white central area), which is were the largest discontinuity in tax rate was observed. Out of all borders to the *Pays de Grandes Gabelles*, we study the borders to the *Quart-Bouillon* (yellow area in the north-west), *Provinces Rédimées* (green area in the south-west) and the *Pays de Salines* (the eastern area including the Alsace, Lorraine and Franche Comté). This choice is motivated by identification considerations, which we discuss in Facts 3 and 4.

Figure 2: AVERAGE AFTER TAX SALE PRICE OF SALT AROUND THE TAX BORDERS (UNTIL 1790)



Source: Authors' own calculations based on official records from the National Library of France, BnF.

Overall, the discontinuities in tax rates between the *Grandes Gabelles* and neighboring regions lead to a substantial gap in salt sale price as illustrated in Figure 2. Distance to the salt tax border in the *Grandes Gabelles* regions is coded negatively. As salt was an essential ingredient to preserve food and animal farming, such sale price discontinuity had large impact in available income around the salt tax borders.

Facts 3 and 4 present – in broad brushes – the rational behind the placement of the different segments of the salt tax border.[13]

[13]For a thorough description of the placement of each segment, see Appendix A.

Fact 3: *Exact* border placement was quasi-random. The spatial integration of the different types of jurisdictions of the Kingdom was minimal, if existent at all. As illustrated in Figure A5, jurisdictions in charge of the local fiscality, the local administration, the military and judiciary, and the dioceses were independently defined and did not overlap. As a consequence, when focusing on the close neighborhood of a specific type of borders, other types of jurisdictions are very unlikely to be confounding.

The placement of the borders to *Quart-Bouillon* and *Pays de Salines* is directed by the underground salt density. Concerning the *Quart-Bouillon*, region B in Figure A1, the tax border coincides with the border of the Bailliage du Cotentin (a sub-administrative jurisdiction within the former duchy of Normandy) which produced large quantities of salt from local salt marshes. This area famously includes the Mont-Saint-Michel salt marshes. Instead of paying a salt tax, 1/4 of the local salt production was ceased by the King: hence, the name "quart-bouillon" which can literally be translated to "quarter of the stock". The produced salt was then sold throughout the kingdom.

Similarly, the *Pays de Salines* (literally Country of Salines, region D in Figure A1) is a region where salt is highly concentrated in the underground. *Saline* – a mixture of salt and water – naturally flows close to the surface. The border between the *Pays de Salines* and the *Pays de Grandes Gabelles* contours the natural sources of saline around the current region of Jura close to the French-Swiss border.

The rationale behind the *Provinces Rédimées* is entirely different. The precise placement of the border between the *Provinces Rédimées* and the *Pays de Grandes Gabelles* is based on the border of the Duchy of Aquitaine when it first joined the French Kingdom in 1137 following the marriage of Alienor of Aquitaine and the French king. However, long before 1137 and until 1472, the exact placement of the border between Aquitaine and France continuously changed. The political and military instability of the area is a consequence of its topology (Kitamura and Lagerlöf, 2019). It coincides with what geologists call the *Seuil du Poitou*, i.e., where the *Paris* (Northeast) and *Aquitaine* (Southwest) sedimentary basins meet, and hence where we observe a gap between the ancient mountain ranges *Massif Armoricain* (Northwest) and the *Massif Central* (Southeast).

When the region finally joined the Kingdom of France in 1472, it was offered a preferential treatment in terms of salt taxation. A tax was still levied but with a much lower rate in the *Pays de Grandes Gabelles*. Then, between 1537 and 1544, the King attempted to uniform (from above) the salt tax rate. This led to large social unrest in the future *Provinces Rédimées*. Given the financial pressure imposed on the Kingdom's finances by the Italian Wars, the King offered the region the possibility to pay a large lump sum fee in exchange of a reduce salt tax rest in the future.

Fact 4: No differences in public service provision around salt tax borders. In the *Ancien Régime*, the provision of public services – in a modern understanding – was minimal. The revenues raised by the Crown via taxes were used for traditional royal prerogatives – namely, military, monetary, justice, infrastructure, police – which are either uniform or vary smoothly in space. Hence, no difference in local public goods provision was observed around the salt tax borders.

3 Data

To study the effect of taxation in the very long-term, this paper exploits a wide variety of administrative data starting before the French Revolution – mid-18th century – until today at regular intervals (approximately 20 years), as well as novel historical micro-data covering a longer time period, 1400-1900. Time invariant agricultural, topological and geographic information is also used. Below we highlight the main data sources used in this paper. The descriptive statistics are displayed in Table A1.

Historical salt tax data. To assign locations to tax zones, we geo-referenced the "Carte des Gabelles" (Figure 1, lit. "Map of the Salt Taxes"). Own digitalization based on original source from the "French national Library" ("Bibliothèque Nationale de France", in French). In the geo-referencing task, we also geo-located information on the salt tax levels.

Demographic data over time. The demographic information used in this paper covers the period 1798-2006. Precisely, we benefit from three datasets produced by the French National Institute of Statistics and Economic Studies. First, contemporary demographic, economic and establishment information is recorded on a yearly level for the last years (2006-2014). Second, historical municipal population count is recorded at regular intervals between 1876 and 2006 by the Historical Population Censuses. Finally, going back to the French Revolution demographic data at the "arrondissement" level is provided on the period 1789-1900.

Historical data from genealogy documents. In order to measure the demographic trend before and after the introduction of the salt tax, we collected additional historical data containing demographic information for a very long period, 1400-1900. In particular, we rely on a set of online genealogy portals and we downloaded these information through web-scraping, with the use of the software Python. Such portals contain historical individual records for France, collected from different documentary sources such as historical censuses, civil registries (including birth, death and marriage certificates), notarial records, courts records, military death registries, military archives and royal and seigneurial (manorial) registries. Moreover, we exploit this data to measure migration across municipalities over time. In particular, the individual information on birth- and death-place allows us to quantify the municipal inflow of migrants at regular time intervals. The final dataset includes historical information on more than 47 millions individuals that lived between the fifteenth and the twentieth century.

Geo-localized contemporary data. To precisely identify the effect of the salt tax in space, we use the 2010 "données carroyées à 1km^2 sur la population" (lit. squared population data at 1 km^2). These data contain the population density at 1 km^2, as well as the average income, the total income and the fraction of poor households, for the individuals residing in a 1 km^2 cell. Figure A6 shows the map with municipalities and the 1 km^2 cells for the three tax areas, adopting a 7km bandwidth.

Natural sources of salt data. To model the salt tax border placement based on local salt availability, we use precise geo-localized geologic data on local salt sources. Precisely, we exploit the geo-location of salt marshes,[14] as well as information on ground salinity across France recorded at fine spatial scale of 30 arc second cells ($\approx$

[14] The geo-location of salt marshes is derived using a novel global dataset on salt marshes produced by Mcowen, Weatherdon, Bochove, Sullivan, Blyth, Zockler, Stanwell-Smith, Kingston, Martin, Spalding, and Fletcher (2017).

950m in France).[15] The geo-location of both types of salt sources is mapped in Figure A7.

Locational fundamentals. To capture natural advantages of locations for development, we study a number of geographic and topographic outcomes: soil fertility provided by the Harmonized World Soil Database (see Figure A14), as well as altitude, distance to major rivers (see Figure A15). We also exploit pre-salt tax spatial data on transport networks using the roman road network at its peak in 117 AD, as well as administrative border information using diocese borders circa 1000 AD (see Figure A16).

4 Empirical Approach

4.1 Identification strategy

Consider $i \in I$ local areas, each is spatially defined by its centroid, $\boldsymbol{c}_i = (c_i^x, c_i^y)$. In the present setting, areas alternatively represent municipalities and 1 km^2 cells. Further, consider $\overline{\boldsymbol{B}}$ as the infinite set of border points constituting the salt tax borders. Let us then define the subset $\boldsymbol{B} \in \overline{\boldsymbol{B}}$ of border points $\boldsymbol{b}_i = (b_i^x, b_i^y)$, such that the euclidean distance to the salt tax border $d_i = ||\boldsymbol{c}_i - \boldsymbol{b}_i||$ is minimized. Finally, define two zones $\mathcal{A}^+$ and $\mathcal{A}^-$ as the treatment (i.e., the low tax area; LTA) and the control (i.e., high tax area; HTA) areas, respectively.

Location relative to the nearest salt tax border acts as the forcing variable. Assignment into treatment is then a function of a municipality's location relative to the border. Formally, treatment status T_i of municipality i is defined as $T_i = \mathbb{1}\left[\boldsymbol{c}_i \in \mathcal{A}^+\right]$. Denote the outcome vector by $\boldsymbol{Y}$. We then focus on the discontinuity of the expected outcomes at the geographical border:

$$\tau(\boldsymbol{d}) \equiv \mathbb{E}[\boldsymbol{Y}_1 - \boldsymbol{Y}_0 | d_i = 0] = \lim_{\boldsymbol{d} \to 0} [\boldsymbol{Y} | \boldsymbol{c} \in \mathcal{A}^+] - \lim_{\boldsymbol{d} \to 0} [\boldsymbol{Y} | \boldsymbol{c} \in \mathcal{A}^-]. \quad (1)$$

As baseline specification, we estimate (1) using local-polynomial regression-discontinuities with robust confidence intervals and optimal bandwidth selection following Calonico, Cattaneo, and Titiunik (2014). The performance of standard local

[15] Ground salinity is measured by the Harmonized World Soil Database.

polynomial estimators may be seriously limited by their sensitivity to the specific bandwidth employed. Hence, we employ mean squared error optimal bandwidths, which are valid given the robust approach in Calonico et al. (2014). When including covariates, we follow the approach in Calonico, Cattaneo, Farrell, and Titiunik (2019).

4.2 Results

In this section we present the main results of the analysis. On the one hand, we focus on the impact on population and economic performance in the long-run, i.e. today. On the other hand, we study the effect in the short-run, relying on rich historical data drawn from many different sources.

4.2.1 Long-term effect

The goal of this, first, analysis is to study the effect of the large tax differentials produced by the *Gabelle* in the long-run, *i.e.* after two hundred years from its abrogation. With this objective, we estimate model 1 on a set of variables measuring population and economic performances in 2006.

Table 1 displays the main results of this analysis, conducted using the optimal bandwidth and polynomial order, according to Calonico et al. (2014). First, column (1) shows that the municipal population density in 2006 (expressed in logarithm) is higher in the LTA than in the HTA.[16] The effect is statistically significant and it is large as it amounts to 26.1% of the dependent variable standard deviation. Figure A8 shows this result graphically: left plot displays the classic RD plot, constructed using the optimal bandwidth of 7.99 Km, and right plot shows the sensitivity analysis where the bandwidth gradually increases from 5 to 20 Km: the coefficient is positive, statistically significant and the effect attenuates as larger bandwidths are used, highlighting its local nature. Second, similar results emerge if we study population with a more fine-grained variation. Columns (2) and (3) of Table 1 show the effect on the number of individuals and households using 1 km^2 cells as unit of variation, and in both cases the effect is positive, statistically significant and large. These findings suggest that municipalities in the LTA are characterized by a significantly higher population

[16]We study population density instead of population in absolute value in order to take into account the size and the territorial extent of municipalities that may vary around the border.

density in 2006.

Second, we focus on economic performance. Columns (4) and (5) of Table 1 show the impact of tax differentials on public and private firms per km^2 (expressed in logarithm), at the municipal level. In both cases, the effect is positive, large and statistically significant, and it amounts to, respectively, 29% and 25% of the dependent variable standard deviation. Moreover, columns (6), (7) and (8) show the effect on the average income (in logarithm), the total income (in logarithm) and the fraction of poor household, measured on 1 km^2 cells: municipalities in the treatment group have a larger average and total income as well as a smaller fraction of poor household. The effects amount, respectively to 5.1%, 8.6% and 5.1% of the dependent variable standard deviation. Graphical outcomes are displayed in Figure 3, RD plots, and in Figure A9, sensitivity analysis. Also in this case the impact on these variables is robust to many bandwidth specifications, and the effect smoothly attenuates as we move away from the salt tax borders. In general, these results document better economic indicators in the LTA.

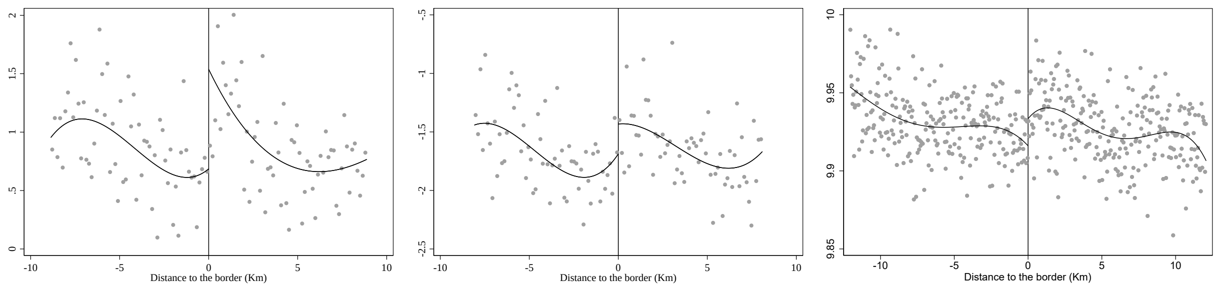
Table 1: Long term impact on population density and economic activity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(a) Population			(b) Economic indicators				
Dep. var.	Municipal pop. density	Individuals $1km^2$ cells	Households $1km^2$ cells	Public estab. (per km^2)	Firms (per km^2)	Av. income $1km^2$ cells	Tot. income $1km^2$ cells	Fr. poor HH $1km^2$ cells
Treatment	0.296**	0.133***	0.136***	0.253**	0.256**	0.007**	0.139***	-0.005**
	(0.135)	(0.029)	(0.029)	(0.108)	(0.111)	(0.003)	(0.030)	(0.002)
N	1322	28448	28321	1473	1345	24645	27789	24810
Opt. bandwidth	7.99	14.34	14.25	8.88	8.09	12.07	13.93	12.18

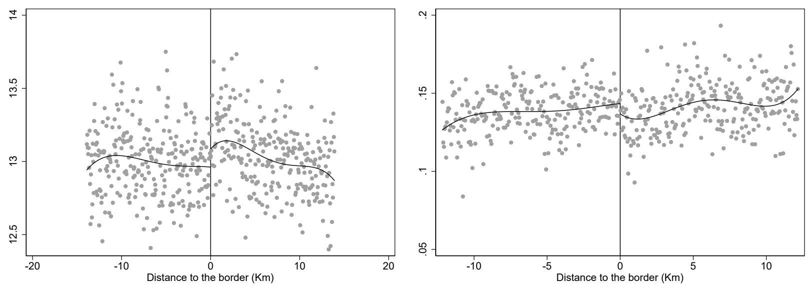
Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. "Municipal population density" refers to 2006 and is expressed in km^2. All variables except the one in column (8) are expressed in logarithm. The specification always includes salt borders fixed effects. In columns (2), (3), (6), (7) and (8) the specification also includes municipal coordinates and residential area. The unit of analysis is the municipality in columns (1), (2), (4) and (5) and the cell of 1 Km^2 size in columns (2), (3), (6), (7) and (8). Robust standard error are included.

Figure 3: LONG-TERM EFFECT ON ECONOMIC INDICATORS

(a) Private firms (per km^2) (b) Public firms (per km^2) (c) Av. income (1 km^2 cells)



(d) Tot. income (1 km^2 cells) (e) Fr. poor HH (1 km^2 cells)



Notes: These plots show non-parametric estimates following Calonico et al. (2014), using a fourth order polynomial and optimal bandwidth. All the dependent variables are expressed in logarithm, except the one in sub-plot e. The unit of analysis is municipality in panels a and b and cells of 1 km^2 size in panels c, d and e. The specification always includes salt border fixed effects and, in panels c, d and e, also municipal coordinates and residential area.

Overall, this analysis shows that the areas subject to the favorable tax rate of the *Gabelle* are more populous and have better economic performances today. These results are among the first to highlight that taxation may have important consequences in (very) long-run period. Indeed, our findings suggest that the the impact of a tax may be highly persistent, showing its effects even two centuries after its abrogation.

4.2.2 Historical analysis: RDD

After the analysis on the long-term effects, we want now to focus on the effects of tax differentials over time, starting right after the abolition of the *Gabelle*, that took place after the French revolution in 1789. In order to conduct this analysis, we rely on many historical data, collected from different sources, that allow to compare local characteristics around the salt tax borders in the 18th, 19th and 20th century. The goal of this analysis is twofold: documenting the impact immediately after the abrogation of the tax, and showing that the differences that we observe today, at the border between LTA and HTA, can be primarily attributed to the *Gabelle*.[17]

To conduct this analysis, we rely on population data –varying both at the municipal and arrondissement level– covering the period 1789-2006. First, we focus on *municipal* population in Table A3. The dependent variable is population density (expressed in logarithm), measured roughly every twenty years starting from 1876. In particular, we study the following years: 1876, 1896, 1911, 1931, 1954, 1975, 1990 and 2006. This extensive analysis offers the unique opportunity to track how population changed around the tax border in almost 150 years. What emerges is that the difference between LTA and HTA in population density was already large in 1876, one century after the abolition of the *Gabelle*, with a positive and significant coefficient and the effect persists over time. Graphical results are shown in Figure 4, which shows the RD plots for each year, and in Figure A10, which displays the sensitivity analysis: also in this case the effect weakens as bandwidths increase.

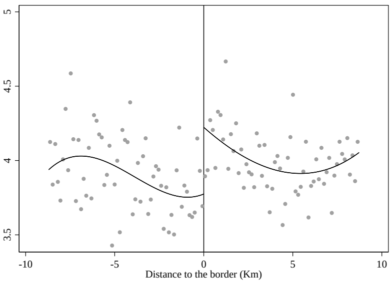
Then, we conduct a second analysis on population density and other demographic variables exploiting the variation at the *arrondissement* level.[18] This allows us to use even older population figures, starting from the late 18th century, the period when the *Gabelle* was abolished. This analysis is displayed in Table 2, Panel a, and it studies population in the following years: 1789, 1801, 1811, 1821, 1831 and 1836. The results confirm that already in the late 18th century and early 19th century the arrondissements in the treatment group were more populous compared to the others. Moreover, in Panel b of Table 2, we study additional demographic variables at the arrondissement level. What emerges is that localities in the LTA are characterized by higher number of newborns, deceased people and marriages. These variables refer to the year 1836.

[17] It is important to notice that, given the difficulty to collect this type of historical data, we are able to conduct this short-term analysis only on demographic variables.

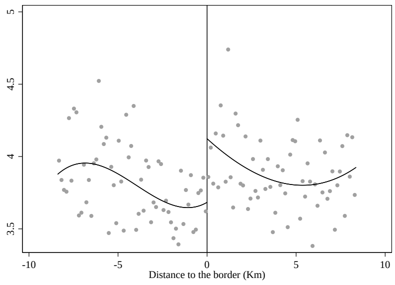
[18] In particular, the data we use at the arrondissement level contain information on the local capital of the corresponding arrondissement. Moreover, it is important to mention that we exclude from the analysis the arrondissements that are cut by the border, as their treatment status is unclear. They represent the 28% of the localities.

Figure 4: Over time effect on municipal population density

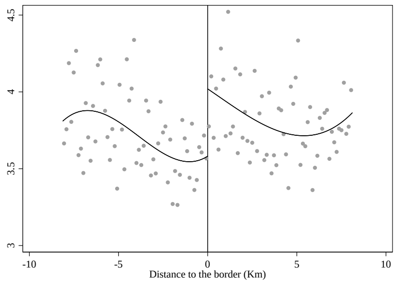
(a) Population density (1876)



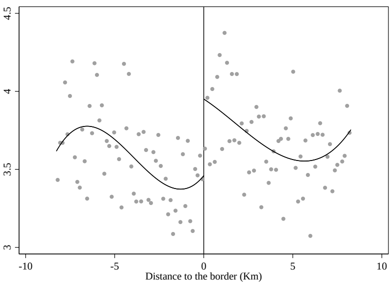
(b) Population density (1896)



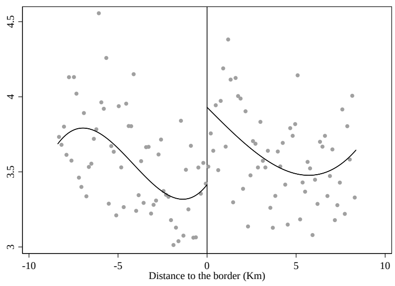
(c) Population density (1911)



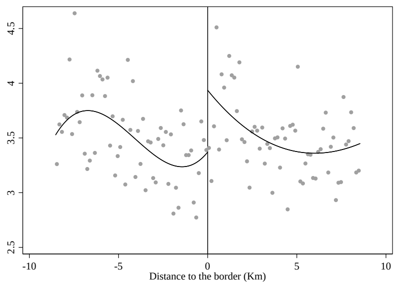
(d) Population density (1931)



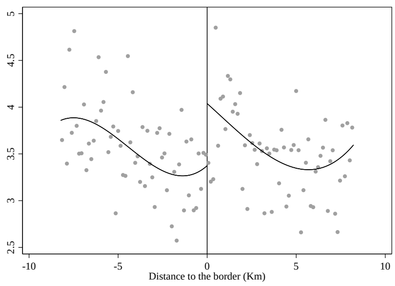
(e) Population density (1954)



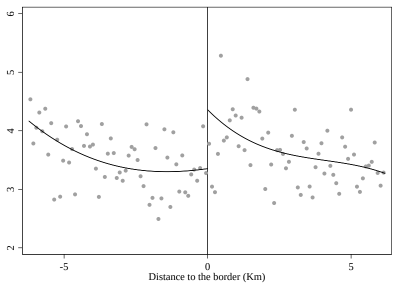
(f) Population density (1975)



(g) Population density (1990)



(h) Population density (2006)



Notes: These plots show non-parametric estimates following Calonico et al. (2014), using a fourth order polynomial and optimal bandwidth. The dependent variables are expressed in km^2 (in logarithm) and the unit of analysis is municipality. The specification always includes salt border fixed effects.

Finally, Figure 5 summarizes the results on population density over time, combining the data at the arrondissement and at the municipal level.[19] Despite the difference

[19] In particular, the figure plots the analyses contained in Tables A3 and 2, conducted using the optimal bandwidth.

Table 2: IMPACT IN THE SHORT-TERM: *ARRONDISSEMENT* DATA

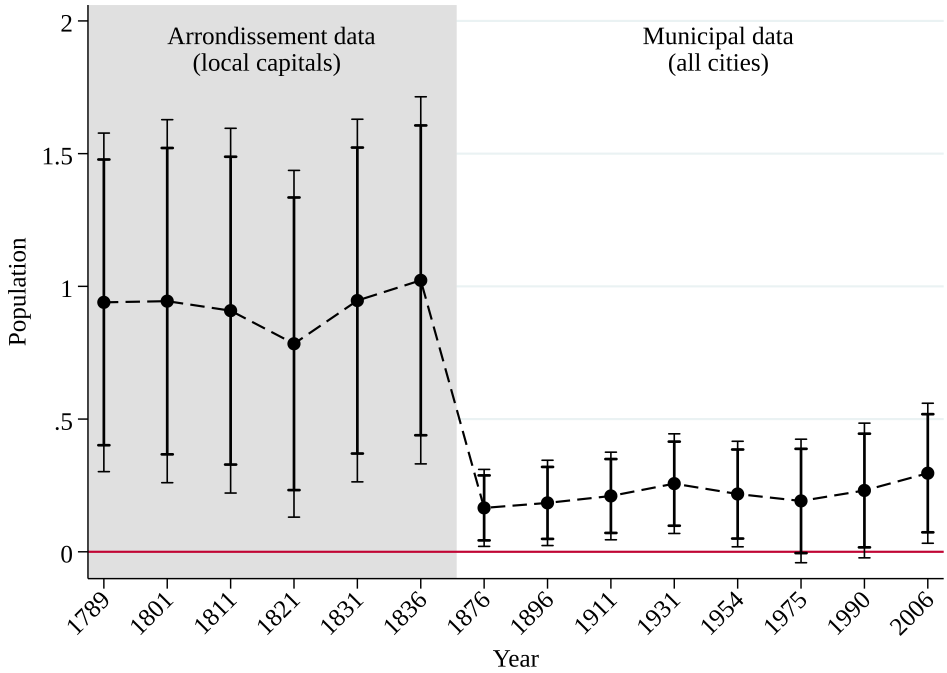
	(1)	(2)	(3)	(4)	(5)	(6)
	(a) Local capital population density					
Reference year:	1789	1801	1811	1821	1831	1836
Treatment	0.940***	0.944***	0.908***	0.784**	0.947***	1.023***
	(0.325)	(0.349)	(0.351)	(0.333)	(0.349)	(0.353)
N	155	160	160	151	142	139
Bandwidth	12.59	12.83	12.83	12.48	12.22	12.16
	(b) Other demographic variables (per km^2)					
	N newborns (1836)	N deceased people (1836)	N marriages (1836)	-	-	-
Treatment	1.246***	1.194***	0.948***	-	-	-
	(0.343)	(0.344)	(0.337)	-	-	-
N	133	126	120	-	-	-
Bandwidth	11.92	11.62	11.15	-	-	-

Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. "Local capital population density" is expressed in km^2 (in logarithm) and refers to the population of the local capital of the corresponding arrondissement. The specification always includes salt borders fixed effects. The unit of analysis is the arrondissement. Variables in Panel b are expressed in km^2 (in logarithm). "Dep. var. mean" indicates the average value of the dependent variable. Robust standard error are included.

in magnitude, due to the fact that the arrondissement data refer to local capitals, it emerges that the difference in population density between the two areas persisted for a very long period of time. The effect is large and very robust.

Overall, the analysis on the short-term effects provides evidence that the difference in population density between LTA and HTA was already in place immediately after the abolition of the salt tax, at the end of the 18th century, and it persists in the following centuries, 19th and 20th. On the one hand these results confirm that the effect observed in the long-run can be attributed to the *Gabelle*, on the other hand they suggest that the two areas did not converge in the centuries following the abrogation of the tax.

Figure 5: Effect on local population density between 1789 and 2006



Notes: The plot shows the estimates contained in Table A3 and 2 (panel a). Coefficient in the shaded area refer to the analysis at the arrondissement level (local capitals), and those in the white area refer to the analysis conducted at the municipal level (all cities).

4.2.3 Historical analysis: Diff-in-Diff

In this section, we want to conduct a dynamic historical analysis with the goal of studying the impact of the salt tax before and after its introduction. To do that we collected a novel, historical, dataset containing individual information for a very long period, 1400-1900. This dataset permits to compare municipalities around the border in the pre- and post-salt tax period, with the implementation of a standard difference-in-differences methodology. Thanks to this alternative empirical strategy, we can control more systematically for fixed local characteristics and corroborate the previous findings.

Novel genealogy database (1400-1900). To create this new dataset, we rely on a series of online portals that contain historical individual records for France, collected from different documentary sources such as historical censuses, civil registries (containing birth, death and marriage certificates), notarial records, courts records, military death registries, military archives and royal and seigneurial (manorial) registries.[20] We downloaded these information through web-scraping, with the use of the software Python.[21]

The final dataset contains historical information on the French population at the individual level, and it has several advantages. First, the time coverage of the data is very wide, spanning between the fifteenth and the twentieth century. Second, rich individual information are available, including name and surname, date of birth, marriage and death and, most importantly, municipality of residence. After a detailed cleaning of the data, in which we exclude incomplete or likely wrong records, the final data include more than 47 millions observations, describing the demographic evolution of 3,803 French municipalities between 1400 and 1900. Figure A11 shows the distribution of birth and death dates for the individuals in the dataset. The coverage clearly improves over time, it is low during the fifteenth and sixteen centuries and it significantly improves from the seventeen century. Finally, we aggregated the individual data at the municipal level creating municipal indicators of population density for regular time intervals (twenty-five years) from 1400 to 1900. Table A2, Panel A, shows the descriptive statistics and confirms the trend already discussed in Figure A11.[22]

Data validity. As the data is novel, we conduct a series of test to assess its validity and relevance in the current setting. The key condition required for the analysis to be valid is that the genealogy data quality varies smoothly at the border. The observation of Figure A11 leads to two important data quality concerns: (i) is the coverage of the data relative to known high-quality administrative data smooth around the border,

[20] For example, the most important historical sources for the city of Paris are the following: 51,1% (civil registries), 3.2% (notarial registries), 2.2% (private archives), 1% (probate registries), 1% (registries of burial), 0.5% (death registries), 0.5% (military registries) and 0.3% (register of voters from Paris).

[21] Given the volume of this data, we only focus on municipalities which are close to the salt tax border (within a bandwidth of 25 Km). The final dataset includes 3,803 municipalities.

[22] Importantly, we also exploit this historical data to create an original measure of migration across municipalities between the fifteen and twentieth centuries. In particular, we rely on individual information of the place of birth and death, and we quantify the inflow of migrants for each municipality. To identify a migration route we focus on individuals whose birth-place is different from the death-place. This procedure allows us to measure the inflows of migrants at the municipal level between 1400 and 1900. Table A2, Panel B, shows the descriptive statistics, and shows an increasing trend over time.

(ii) is the reduction in observations for earlier time periods (especially, around and before 1600) smooth around the border?

Table 3 answers the first concern using a RD approach (see Section 4.1). It compares the municipal population count and density recorded in the genealogy database (in 1901) relative to the official 1901 population census.[23] Panel (a) compares both databases using simple difference at the municipal level, whereas Panel (b) looks at the absolute difference at the municipal level. Columns (1), (2), (3) and (4) differ in the metric used for the dependent variable: raw error (C1), error in density per km^2 (C2), log-raw error (C3), and log-error in density per km^2 (C4). Overall, the error between the 1901 vintages of the genealogy data and the census does not appear to vary at the salt borders significantly.

Table 3: Validating genealogy data based on the 1901 population census

	(1)	(2)	(3)	(4)
Dep. var.	(a) Simple difference: Genealogy data - Census			
Functional form:	Raw error	Density per km^2	Logarithm	Log. density per km^2
Treatment	-273.128	-0.214	-13.957	-0.214
	(303.321)	(0.154)	(28.654)	(0.154)
N	1,053	1,331	1,168	1,331
Opt. bandwidth	7.24	9.25	8.11	9.25
Dep. var.	(b) Absolute difference: || Genealogy data - Census ||			
Functional form:	Raw error	Density per km^2	Logarithm	Log. density per km^2
Treatment	-187.359	0.070	2.467	0.070
	(253.133)	(0.131)	(25.277)	(0.131)
N	1,214	1,263	1,266	1,263
Opt. bandwidth	8.40	8.74	8.74	8.74

Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. Robust standard error are included.

Table 4 investigates whether municipalities may be missing from the data in earlier years in a non-random manner around the border. A missing municipality in a

[23]We chose 1901 as comparison year for two reasons. First, both genealogy and census data are available for that period. Second, it is sufficiently distant in time from the 1870 Franco-Prussian War and the First World War.

given period is defined as a municipality with zero resident in that period. Consequently, we construct a municipal-period indicator equals to one if the municipality is missing in that period, and zero otherwise. We focus on the period before (and including) 1600 as from 1650 the number of missing municipalities is too small for identification purposes. Using a RD approach, Table 4 shows that no significance difference in the number of missing municipalities is observed between 1400 and 1600 around the border using 50 years time intervals.

Table 4: VALIDATING THE HISTORICAL COVERAGE OF THE GENEALOGY DATA (1400-1600)

	(1)	(2)	(3)	(4)	(5)
Dep. var.	Municipalities with missing data ($\mathbb{1}\left[\text{missing data}\right]$)				
Reference year:	1400	1450	1500	1550	1600
Treatment	0.006	0.025	-0.025	0.025	0.099
	(0.089)	(0.097)	(0.132)	(0.141)	(0.094)
N	297	284	309	282	387
Opt. bandwidth	2.72	2.53	2.85	2.52	3.50

Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. Robust standard error are included. Test stops at 1600 as beyond that mark there are too few municipalities with missing data for estimation purposes.

Empirical approach. Differently from the administrative data that we use in the previous analysis, whose coverage begins in the late eighteenth century, this dataset allows to study the evolution of population density before and after the introduction of the salt tax. Therefore, we can implement a standard difference-in-differences model to study the impact of the introduction of the salt tax border. Nevertheless, as shown in Figure A2, the introduction of the salt tax in the three special areas took place in different moments in time: first, the border of the *Quart-Bouillon* was established in 1246, second, the one of the *Provinces Rédimées* dates back to 1553 and, finally, the border of the *Pays de Salines* was established more recently, in 1678. Given the time coverage of our data, we can conduct this analysis only on the last two borders. The estimated model is as follows:

$$y_{it} = \alpha_1 + \alpha_2 LTA_i + \alpha_3 LTA_i \cdot Post_t + \gamma_i + \delta_{dt} + \epsilon_{it} \tag{2}$$

where y_{it} represents the dependent variable of the analysis, population density (expressed in log) for municipality i in period t, LTA_i is a dummy variable indicating the localities in the low tax area, the treatment group, and $Post_t$ is the dummy indicating the period after the introduction of the salt tax border (the years after 1553 for cities in the *Provinces Rédimées* and the years after 1678 for cities in the *Pays de Salines*). Moreover, γ_i and δ_{dt} capture municipal and department-year fixed effects, respectively. The DID estimator is obtained by the interaction term $LTA_i \cdot Post_t$ which captures the effect of the introduction of the salt tax in the treatment group (low tax area). Finally the standard errors are cluster at the municipal level. For the sake of clarity, we conduct two independent analysis for the two distinct tax borders.

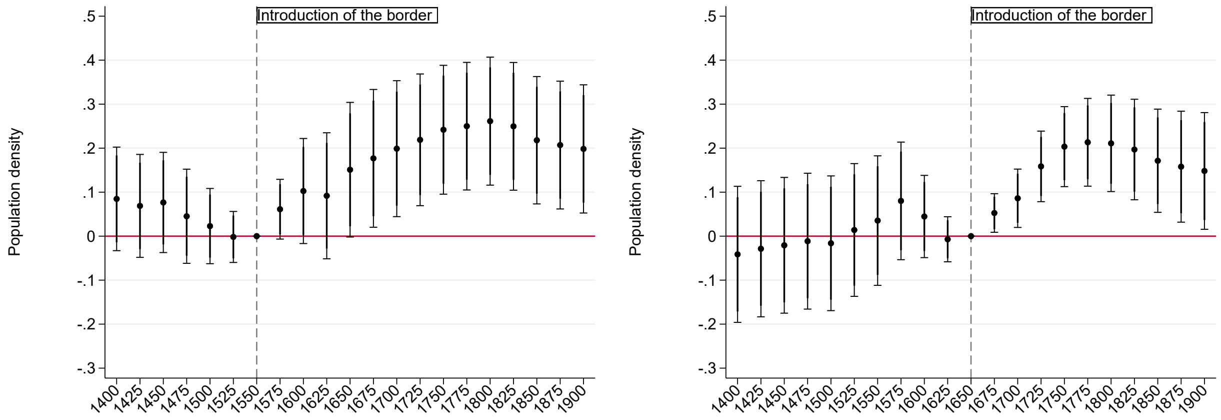
Results. Figure 6 shows the main results of this analysis (numerical results are reported in Table A4). First, left panel of the figure focuses on the border between the *Pays de Grandes Gabelles* and the *Provinces Rédimées*. The figure documents large effects after the implementation of the border. First, there is no evidence of pre-trend as population density is similar in the two areas before the introduction of the tax. Second, after the implementation of the border, population density in the LTA gradually increases: the effect is large and statistically significant and it reinforces over time. Similar results emerge in the right panel of Figure 6, which focuses on the border between the *Pays de Grandes Gabelles* and the *Provinces de Salines*. Also in this case, municipal density begins to diverge after the introduction of the border with a large and significant effect.

These findings shed new light on the effect of the salt tax on population density. Besides confirming the results of the previous sections, they show that LTA and HTA started diverging when the tax has been introduced, while they were similar previously. Therefore, this result provides evidence that the difference in local development around the border is likely to be due to the tax itself, rather than to other characteristics. Nonetheless, the absence of pre-trends suggests that the areas around the border were comparable and did not differ in key local features. This provides a further support to the identification assumptions of the RDD analyses conducted in the previous sections.[24]

[24]Furthermore, in both graphs, the coefficient reaches a peak in 1800, starting declining afterwards. This coincides with the abrogation of the tax during the French Revolution and it further confirms that

Figure 6: Effect on municipal population density (1400-1900)

(a) Provinces Rédimées (b) Provinces de Salines



Notes: These plots show the difference-in-differences estimates of model 2 comparing municipalities in the LTA and HTA areas. The dependent variable is municipal population density (expressed in logs) aggregated in periods of 25 years. The specification always includes municipal and department-year fixed effects.

Finally, we explored whether the observed effect varies across different age groups. In particular, we study the impact on the number of individuals (per squared Km) for young, up to 16 years old, adult, between 17 and 50 years old, and senior population, above 50 years. Figure A12 shows these results. The impact of the salt tax emerges in different moments for the three age groups: first, the impact on the young population is immediate, as it appears in the first period, second, the effect on adult population emerges after one or two periods and, finally, the impact on senior population is only visible after many periods. These results confirm that the demographic growth started diverging in the LTA just after the introduction of the border with an increase of fertility in the area. Moreover, these findings suggest a plausible mechanism for the main findings which will be discussed in greater detail in the mechanism section.

4.3 Validity

To validate the empirical analysis above, we present a series of validity tests. First, we run balancing tests around the salt tax borders based on time-invariant locational fundamentals, historical variables, as well as pre-salt tax individual characteristics.

these trends originate from the differential salt tax rates.

Second, we exploit a specificities of the French historical salt tax system – namely, that low tax areas coincides with areas with access to salt – to inform a fuzzy regression discontinuity design in which distance to salt sources (either salt marshes or underground salty water) constitutes the running variable in a first stage. This tests aims at tackling potential endogeneity problems that arise if the historical placement of the borders was not random. Note that the flat pre-trends in the DiD analysis in Figure 6 already indicate that the borders were not targeting historical local population counts. Third, we use placebo tax borders to formally test that the variables in analysis show a discontinuity exclusively around the border of the salt tax. To do so, we adopt a set of fake spatial borders: the border is permuted from -40km to +40km, with 10km of increments. Overall, all validity tests support the RDD and DiD results.

Balancing tests. To test for possible double treatment-type threats to identification in a spatial border setting, one commonly resorts to balancing tests around the discontinuity studied. The very long-term nature of the research question at hand could render this approach ineffective. Indeed, many (if not most) local characteristics have likely been impacted by the tax discontinuity – directly or indirectly – in the last ≈ 500 years.

However, this is not the case for all observed variables. Indeed, testing for discontinuities at the salt tax border in historical (pre-salt tax) variables as well as constant geographic characteristics may offer some insurance against double treatment identification threats. Figure A13 shows the placement of the salt tax borders relative to historical (i.e., diocese borders circa 1000 AD) and contemporary (i.e., department borders) administrative borders. The salt tax borders do not overlap with any of the two types of administrative borders. This is particularly visible when considering a 7km bandwidth – used above to estimate the effect of the salt tax differential – around the salt tax border. Moreover, Table A5 tests for significant differences around the salt tax borders in: soil fertility, distance to the nearest border, high altitude location, and connection to the roman road network (circa 117 AD). Overall, no significant discontinuity at the salt tax border is observed.

Moreover, the historical micro-data we use in the DiD analysis, allows us to conduct balance checks on a battery of demographic characteristics *before* the introduction of the salt tax. In particular, we aggregate individual information in the 50 years preceding the introduction the Gabelle at the municipal level.[25] Table A6 reports the results of this test focusing on the following variables: share of Aristocrats, female population and married people (total and by gender), as well as life expectancy (total and by gender) and the average marriage age (total and by gender). Most of these variables do not show any discontinuity around the tax border further validating the main empirical strategy.

Instrumental variable analysis: Fuzzy RDD. As already discussed in the previous sections, the exact location of the different tax borders is plausibly exogenous. Moreover, Figure 6 reports similar pre-trends around the border. Yet, we propose an alternative identification strategy that exploits the peculiar institutional setting under analysis to further reinforce the exogeneous borber placement claim. Namely, the areas subject to low tax rates are usually characterized by a favourable access to the production sites of salt, either because they are close to salt marshes or close to underground salt mines.[26] For instance, municipalities located in the *Quart bouillon* area are close to the salt marshes of Normandy, and the area of *Pays de Salines* is contiguous to the large salt mines of Jura. This pattern appears clearly when considering the geo-location of both types of salt sources in Figure A7.

Therefore, we exploit location of salt sources relative to municipalities to predict the treatment status of a certain municipality, i.e. whether the municipality is located in the HTA or in the LTA. Formally, we estimate a fuzzy RDD (Calonico et al., 2014; Calonico, Cattaneo, and Farrell, 2020) where we predict the distance to the salt tax border in km with the distance in km to the closest salt marsh and salt mine for a municipality. Importantly, this instrumental variable model is *local*, i.e. it is estimated on municipalities that are sufficiently close to the salt tax border (using the optimal bandwidth according to Calonico et al., 2014). The exclusion restriction requires that the proximity to salt production sites is plausibly exogenous with respect to the outcome variables. This is reasonable in our context as, first, the salt industry

[25]Notably we are considering the period 1500-1550 for municipalities close to the *Provinces Rédimées* border, and 1625-1675 for municipalities close to the *Pays de Salines*.

[26]Indeed, as already discussed, the access to salt has been in some cases the reason of the introduction of a different *Gabelle* system in these special areas. This is the case, for instance, of the *Quart-bouillon* area, where the salt was obtained boiling the sea sand and the producers had to give one fourth of the product to the king.

was marginal in the economic system of France at the time, and, second, we are comparing municipalities that are spatially very close and therefore this distance reduces the accessibility of salt on either sides of the border only marginally.

The results of this analysis are shown in Table A7. The first stage is highly significant in all cases, as revealed by the p-value of the first stage. Panel (a) displays the effects in the long-run: the main results are confirmed as localities in the LTA appear to be more populous (columns 1-3) and characterized by better economic indicators (columns 4-8). Secondly, panel (b) focuses on the impact on population over time and also in this case the positive and significant effect is confirmed. In terms of magnitude, both panels show that the coefficients with the IV approach are smaller than the RD estimates. This reveals that some strategic placement of the salt tax border should not be excluded. However, even if this may have happened, the results are still strong and significant.

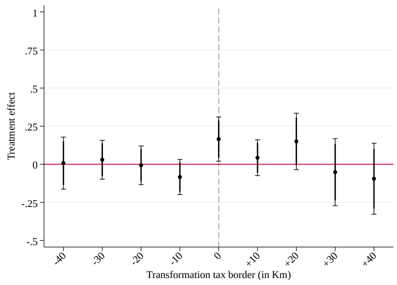
Placebo tax borders. An additional potential threat to our identification is that the border of the *Gabelle* is capturing other spatial features, in the regions under consideration, that may affect local economic and demographic indicators. Therefore, we formally test that the variables in analysis show a discontinuity exclusively around the border of the salt tax. To do that we conduct a set of placebo tests in which we adopt a set of fake spatial borders: the border is permuted from -40km to +40km, with 10km of increments.[27]

Figure 7 shows the results of these placebo tests, on the main variables of the analysis. For the sake of clarity, we also include in the plots the coefficient of the analysis conducted on the *correct* border, corresponding to the value 0 in the x-axis. The coefficients in the graphs are always very small and non significant for the perturbed salt-tax borders. This finding confirms that the main results of the analysis can be correctly attributed to the differences in the system of the salt-tax.

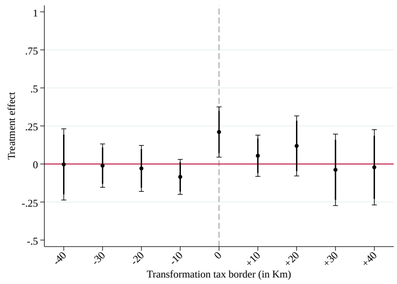
[27]This test is also useful to confirm that the geo-localization of the salt-tax border that we conduct in the current map of France is accurate.

Figure 7: Analysis on placebo tax borders

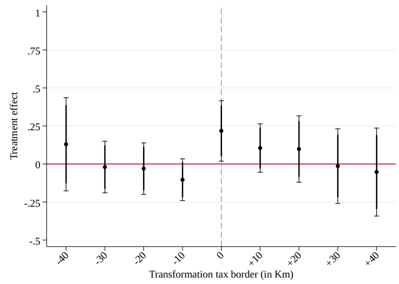
(a) Population density (1876)



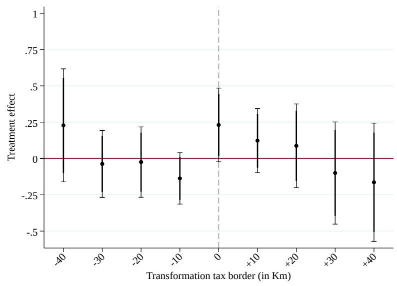
(b) Population density (1911)



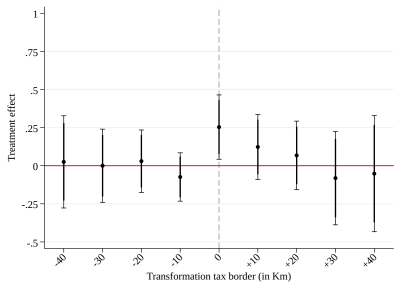
(c) Population density (1954)



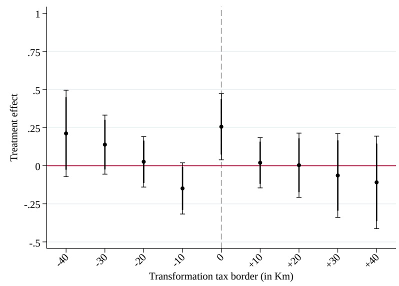
(d) Population density (1990)



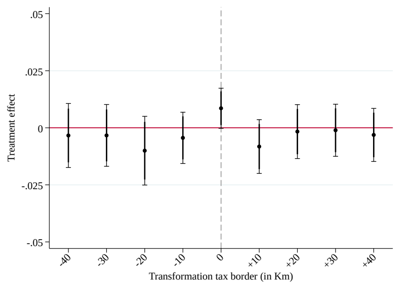
(e) Private firms (per km^2)



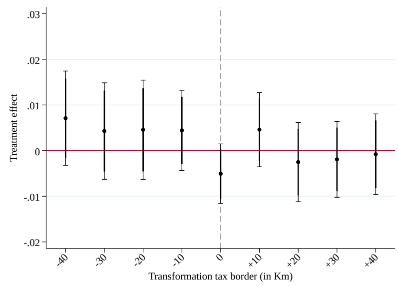
(f) Public estab. (per km^2)



(g) Av. income (1 km^2 cells)



(h) Fr. poor HH (1 km^2 cells)



Notes: These plots show the non-parametric estimates, following Calonico et al. (2014), conducted using a placebo border. In panels g and h a bandwidth of 5km is used. The border is permuted from -40km to +40km, with 10km increments. The analysis with value a transformation value of 0 represents the analysis conducted with the correct border. The dependent variables are expressed in km^2 (in logarithm) in panels a-f and and in cells of 1 km^2 in panels g and h. The specification always includes salt border fixed effects and, in panels g and h, also municipal coordinates and residential area.

5 Mechanism

The main results of the paper suggest that the areas subject to the favorable Gabelle rate show better demographic outcomes and economic performances over time, and these effects seem to persist until today. In this section we provide a discussion on the main mechanisms that likely induced these profound economic changes. We start by testing possible population growth effects via migration and increased fertility, before turning our attention to productivity and economic sorting mechanism. We conclude by a discussion of additional channels that may have played a role, but that are unlikely to be driving the observed results.

5.1 Population growth via migration and fertility

Figure 6 shows that the population in the LTA increased significantly following the introduction of the Gabelle. To understand this rapid reaction in population, we investigate two channels: (i) migration from the HTA to the LTA, (ii) increased fertility in the LTA.

Migration. Studying empirically the contemporaneous migration effects – at the local level – of a pre-Revolution policy is naturally difficult due to data limitations. We circumvent this problem by making use of our novel genealogy database which records an individual's place of birth and place of death. As already discussed, we consider that if the former differs from the later, the individual migrated between (at least) these two locations. Using this data, we study how the inflow of migrants to the LTA changed after the introduction of the salt tax; as well as how this introduction impacted the size of bilateral LTA municipality-to-HTA municipality migration flows.

In Table A8, we first present the results of a difference-in-differences analysis, where the dependent variable is the municipal inflow of migrants, and we compare municipalities in the LTA or HTA over time. The analysis covers the time span 1400-1900, with 25 years time intervals. The treatment dummy captures the municipalities in the *Provinces Rédimées* (in column 1) and in the *Pays de Salines* (in column 2). The post dummy indicates the years after the introduction of the salt tax border: it captures the years after 1553 in column (1) and those after 1678 in column (2). All municipalities within a 25km bandwidth of the border are considered. We find that the inflow of migrants after the introduction of the salt tax increased significantly in the LTA municipalities, compared to the HTA municipalities.

In Table A9, we show the results of an event-study estimation of the impact of the salt tax's introduction on the size of bilateral LTA municipality-to-HTA municipality migration flows.[28] Intuitively, we want to see if the HTA-to-LTA migration flows increased after the introduction of the salt tax for the first time in out time span (i.e. in the *Provinces Rédimées* in 1553).[29] Column (1) of Table A9 shows the baseline result. We find that the number of migrants between the average pair of HTA-LTA municipality increased by 0.032 individuals after the introduction of the Gabelle. Furthermore, in column (2), we focus on the extensive margin by studying whether more flows were "opened" after the introduction. Indeed, we find that significantly more connections were used after the tax was introduced.

These two analyses provide evidence that migration, mostly from HTA, significantly contributed to the demographic increase in LTA municipalities after the introduction of the salt tax.

Increased fertility. A relative increase in fertility in the LTA could also participate to the relative population growth effect observed. As already discussed, the heterogeneous dynamics observed in Figure A12 provide some evidence on this channel. The young population increases immediately after the introduction of the Gabelle, whereas it takes longer for the adult and the senior populations. This suggests that fertility may have increased as a direct consequence of the lower tax rate, as the independent spatial mobility of individuals below 16 years old was very limited.

[28] Formally, we estimate the following model:

$$flow_{ijt} = \beta \mathbf{1}\left[t > 1553\right] + \mu_i + \nu_j + year_t + \varepsilon_{ijt}, \quad s.t. \quad i \in HTA, j \in LTA, \tag{3}$$

where $flow_{ijt}$ is the flow of migrants between municipality i and municipality j in year t, $\mathbf{1}\left[t > 1553\right]$ is a "post" indicator variable equal to unity for all years after the salt tax introduction in the *Provinces Rédimées* in 1553, μ_i and ν_j are i- and j-specific fixed effects, $year_t$ is a time trend, and ε_{ijt} is the error term.

[29] As we study flows from the HTA overall, we do not differentiate between the introduction of the tax in the *Provinces Rédimées* and in the *Pays de Salines*, we simply use as benchmark the first year of introduction of the tax in the period 1400-1900 for the entire sample of municipalities.

5.2 Productivity, economic sorting and income

To understand why the introduction of the salt tax has impacted economic development in the HTA relative to the LTA, we first discuss how population growth may have led to economic growth using recent advances in the urban and economic geography literature. Second, we look at more direct channels of the tax on economic development and sorting.

From population growth to increased productivity. The connection between population density and productivity has been recognized and empirically assessed by the urban and economic geography literature (see, e.g., Fujita and Ogawa, 1982; Ahlfeldt, Redding, Sturm, and Wolf, 2015; Desmet, Nagy, and Rossi-Hansberg, 2018; Allen and Donaldson, 2020). In these frameworks, proximity to higher population/worker density leads to increase local productivity. Allen and Donaldson (2020) further identify a positive association between local productivity and past population, additionally to contemporaneous population. Given the population gap induced by the salt tax, one could then expect the LTA to develop higher local productivity levels which would translate over time in the contemporaneous effects that we observe in firm density and private income (Table 1 and Figure 3).

Moreover, both historical and contemporary empirical evidence suggest that the observed migration patterns may have led to increased economic activity in the LTA. Positive selection into migration may bring benefits to the destination locations. For instance, using historical Spanish data, Beltrán Tapia and de Miguel Salanova (2017) find that migrants were on average more skilled – higher literacy levels – than non-migrants. Migrants may also exhibit more entrepreneurial behavior. This is supported by Anelli, Basso, Ippedico, and Peri (2020), who finds significantly lower firm creation in region with larger emigration. In the French context, Mitaritonna, Orefice, and Peri (2014) show that a regional increase in foreign born workers induces an increase in firm productivity.

Sorting and economic gains. As the Gabelle was a tax on salt, it is not far fetch to imagine that economic activities relying relatively more on this resource for production would tend to locate over-proportionally in the LTA. Livestock farming – relative to crop farming – is a typical example of a wide-spread economic activity of the *An-*

cien Régime which requires salt for production. In Table A10, we study the long term effect of the salt tax on agricultural activity and composition at the municipal level. Column (1) focuses on the density of agricultural firms per km^2, whereas Columns (2) and (3) look at the share of agricultural firms growing crops and raising livestock, respectively. The density of agricultural firms follows the results observed for all firms in Table 1: a lower salt tax implies more agricultural firms in the long run. Interestingly for the mechanism discussion, we do observe a sorting of agricultural activity around the historical salt tax border. The low tax area focused relatively more on raising livestock (more intensive in salt) and less on growing crops (less intensive in salt). This sorting result is interesting in itself. Yet, it also brings a new light to the income gap observed at the border.

French rural historians have shown that livestock farming – and owning healthy livestock in general – offered additional sources of revenues. Moriceau (2011) cites two main additional benefits. First, livestock could be rented by other farmers in exchange of both direct monetary compensation and a share of the benefits from the final produced goods. This common historical lease agreement was called the "bail á cheptel". Naturally, larger benefits could be experienced when owning more and/or healthier animals. Second, owning more and/or healthier animals allowed residents of the LTA to generate a secondary source of income by selling animal products (i.e., milk, wool, etc) on the local markets. Note that these benefits were not reserved to livestock farmers, but could be enjoyed (in smaller proportions) by anyone owning one or more animals. Overall, the availability of cheap salt led the LTA to benefit more from these additional sources of revenues.

5.3 Other channels

Other channels may have played a role, but are unlikely to be prime determinants.

Attitudes and institutions. Over time, attitudes and institutions may have evolved more favorably for economic activity and welfare in the LTA. For instance, a long-term lower tax rate may have affected entrepreneurial attitudes which could explain the higher firm density and income in the LTA. Whereas this mechanism may have developed over time, it is not compatible with the rapidity at which the effect of the tax introduction materialized. In the *Pays de Salines*, for instance, Figure 6 shows that a significant effect in population density is already observed within 25 years of the tax introduction.

Smuggling. Finally, historical evidence suggest that the higher accessibility of the salt in the LTA led to smuggling activities around the salt borders. Such activities would lead to higher economic opportunities and revenues in the LTA – which could explain the effects observed. Yet, two observations indicate that this channel was likely secondary. First, historical sources estimate that a total of around 2,000 families lived thanks to this illegal commerce (Hugo, 1838). While this is not trivial, it remains very small considering the size of the area considered. Second, most of these families resided in salt extraction locations (i.e., in close proximity of the sea, salt marches, or salt sources). The vast majority of these locations are out of the optimal bandwidth used to estimate the main results (i.e., between 7km and 14km, Table 1).

6 Conclusion

This paper is among the first to study the (very) long-term effect of taxes on economic geography and development. To address this research question, we exploit the natural experiment created by the *Gabelle du sel*, that generated a series of discontinuities in the tax rate over the territory of the French kingdom. We focus on municipalities located close to these salt-tax borders to estimate a spatial RDD model. Importantly, the exact location of these borders can be considered as plausibly exogenous as they did not coincide with old administrative or historical boundaries; moreover, we provide evidence that geographical and historical characteristics are balanced in the two areas.

First, we document an effect in the long-term, showing that the areas subject to a favorable tax rate have higher population density and economic indicators today. Second, we show that these effects emerged with the introduction of the tax, in the *Ancien Régime*, and they persist in the following centuries, until today. These results suggest that the design of taxes has a profound impact on the economy and the society which is able to persist for a very long period of time. This finding has important policy implications. For instance, it can inform the debate on the so-called "Global

Tax Agreement":[30] the key findings in this paper should reassure decision makers in traditionally low tax countries who may fear the economic costs of such agreement for their economy. Overall, the policy implications of this paper are large and highlight how important in the long-term can be having tax systems that are designed in a fair and efficient way.

[30]The "Global Tax Agreement" was brokered by the Organization for Economic Cooperation and Development (OECD) and endorsed by 137 countries and jurisdictions. It is widely considered to be (one of) the most significant global tax reform in decades. Among other features, the agreement introduces new taxing rights irrespective of a MNE's physical location and a new global minimum corporate income tax of 15 percent on the largest ones.

References

Acemoglu, D., S. Johnson, and J. A. Robinson (2001). The colonial origins of comparative development: An empirical investigation. *American economic review 91*(5), 1369–1401.

Adhikari, B. (2020). Does a value-added tax increase economic efficiency? *Economic Inquiry 58*(1), 496–517.

Ahlerup, P., T. Baskaran, and A. Bigsten (2015). Tax innovations and public revenues in sub-saharan africa. *The Journal of Development Studies 51*(6), 689–706.

Ahlfeldt, G. M., S. J. Redding, D. M. Sturm, and N. Wolf (2015). The economics of density: Evidence from the berlin wall. *Econometrica 83*(6), 2127–2189.

Alavuotunki, K., M. Haapanen, and J. Pirttilä (2019). The effects of the value-added tax on revenue and inequality. *The Journal of development studies 55*(4), 490–508.

Alinaghi, N. and W. R. Reed (2021). Taxes and economic growth in oecd countries: A meta-analysis. *Public Finance Review 49*(1), 3–40.

Allen, T. and D. Donaldson (2020, November). Persistence and path dependence in the spatial economy. Working Paper 28059, National Bureau of Economic Research.

Anelli, M., G. Basso, G. Ippedico, and G. Peri (2020). Does Emigration Drain Entrepreneurs? Technical report.

Bai, Y. and R. Jia (2020). The economic consequences of political hierarchy: Evidence from regime changes in china, 1000-2000 ce. *The Review of Economics and Statistics*, 1–45.

Barro, R. J. and X. Sala-i Martin (1992). Convergence. *Journal of Political Economy 100*(2), 223–251.

Beaulieu, E.-P. (1903). *Les Gabelles sous Louis XIV*. Paris.

Becker, S. O., I. Grosfeld, P. Grosjean, N. Voigtlander, and E. Zhuravskaya (2020). Forced migration and human capital: Evidence from post-wwii population transfers. *American Economic Review 110*(5), 1430–63.

Beltrán Tapia, F. J. and S. de Miguel Salanova (2017). Migrantsâ€™ self-selection in the early stages of modern economic growth, spain (1880â€“1930). *The Economic History Review 70*(1), 101–121.

Bleakley, H. and J. Lin (2012). Portage and path dependence. *The Quarterly Journal of Economics 127*(2), 587–644.

Bleakley, H. and J. Lin (2015, May). History and the sizes of cities. *American Economic Review 105*(5), 558–63.

Burchardi, K. B., T. Chaney, T. A. Hassan, L. Tarquinio, and S. J. Terry (2020). Immigration, innovation, and growth. Technical report, National Bureau of Economic Research.

Calonico, S., M. Cattaneo, and M. Farrell (2020, 11). Optimal bandwidth choice for robust bias corrected inference in regression discontinuity designs. *The Econometrics Journal 23*.

Calonico, S., M. D. Cattaneo, M. H. Farrell, and R. Titiunik (2019, July). Regression Discontinuity Designs Using Covariates. *The Review of Economics and Statistics 101*(3), 442–451.

Calonico, S., M. D. Cattaneo, and R. Titiunik (2014). Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica 82*(6), 2295–2326.

Chanel, G. et al. (2015). Taxation as a cause of the french revolution: Setting the record straight. *Studia Historica Gedanensia 2015*(2015), 65–81.

Davis, D. R. and D. E. Weinstein (2002, December). Bones, bombs, and break points: The geography of economic activity. *American Economic Review 92*(5), 1269–1289.

Davis, D. R. and D. E. Weinstein (2008). A search for multiple equilibria in urban industrial structure. *Journal of Regional Science 48*(1), 29–65.

Dell, M. (2010). The persistent effects of peru's mining mita. *Econometrica 78*(6), 1863–1903.

Desmet, K., D. K. Nagy, and E. Rossi-Hansberg (2018). The geography of development. *Journal of Political Economy 126*(3), 903–983.

Diamond, P. A. and J. A. Mirrlees (1971). Optimal taxation and public production i: Production efficiency. *The American economic review 61*(1), 8–27.

Fouka, V. and J. Voth (2016). Collective remembrance and private choice: German-greek conflict and consumer behavior in times of crisis. *Stanford Center for International Development Working Paper No 587*(6), 26.

Franco, A. P., S. Galiani, and P. Lavado (2021). Long-term effects of the inca road. Technical report, National Bureau of Economic Research.

Fujita, M. and H. Ogawa (1982). Multiple equilibria and structural transition of non-monocentric urban configurations. *Regional Science and Urban Economics 12*(2), 161–196.

Galletta, S. and T. Giommoni (2020). The effect of the 1918 influenza pandemic on income inequality: Evidence from italy. *Available at SSRN 3634793*.

Ganong, P. and D. Shoag (2017). Why has regional income convergence in the U.S. declined? *Journal of Urban Economics 102*(C), 76–90.

Glaeser, E. L. and A. Shleifer (2002). Legal origins. *The Quarterly Journal of Economics 117*(4), 1193–1229.

Grigoli, L. and B. Maione-Downing (2013). France. Diocese and Archdiocese Boundaries ca. 1000.

Herrendorf, B., A. Valentinyi, and R. Waldmann (2000). Ruling Out Multiplicity and Indeterminacy: The Role of Heterogeneity. *Review of Economic Studies 67*(2), 295–307.

Hugo, A. (1838). France militaire. *Histoire des armées françaises de terre et de mer de 1792 à 1837 5*.

Jones, L. E., R. E. Manuelli, and P. E. Rossi (1993). Optimal taxation in models of endogenous growth. *Journal of Political Economy 101*(3), 485–517.

Juhász, R. (2018). Temporary protection and technology adoption: Evidence from the napoleonic blockade. *American Economic Review 108*(11), 3339–76.

Juhász, R., M. P. Squicciarini, and N. Voigtländer (2020). Technology adoption and productivity growth: Evidence from industrialization in france. Technical report, National Bureau of Economic Research.

Keen, M. and B. Lockwood (2010). The value added tax: Its causes and consequences. *Journal of Development Economics 92*(2), 138–151.

Kim, S. (1995). Expansion of markets and the geographic distribution of economic activities: The trends in u. s. regional manufacturing structure, 1860-1987. *The Quarterly Journal of Economics 110*(4), 881–908.

King, R. G. and S. Rebelo (1990). Public policy and economic growth: Developing neoclassical implications. *Journal of Political Economy 98*(5), S126–S150.

Kitamura, S. and N.-P. Lagerlöf (2019, 07). Geography and state fragmentation. *Journal of the European Economic Association 18*(4), 1726–1769.

Kleinman, B., E. Liu, and S. J. Redding (2021, July). Dynamic spatial general equilibrium. Working Paper 29101, National Bureau of Economic Research.

Krugman, P. (1991). History versus expectations. *The Quarterly Journal of Economics 106*(2), 651–667.

Markevich, A. and E. Zhuravskaya (2018). The economic effects of the abolition of serfdom: Evidence from the russian empire. *American Economic Review 108*(4-5), 1074–1117.

Matsuyama, K. (1991). Increasing Returns, Industrialization, and Indeterminacy of Equilibrium. *The Quarterly Journal of Economics 106*(2), 617–650.

McCormick, M., G. Huang, G. Zambotti, and J. Lavash (2013). Roman Road Network (version 2008).

Mcowen, C. J., L. V. Weatherdon, J.-W. V. Bochove, E. Sullivan, S. Blyth, C. Zockler, D. Stanwell-Smith, N. Kingston, C. S. Martin, M. Spalding, and S. Fletcher (2017). A global map of saltmarshes. *Biodiversity Data Journal 5*.

Michalopoulos, S. and E. Papaioannou (2013). Pre-colonial ethnic institutions and contemporary african development. *Econometrica 81*(1), 113–152.

Mitaritonna, C., G. Orefice, and G. Peri (2014, March). Immigrants and Firms' Productivity: Evidence from France. IZA Discussion Papers 8063, Institute of Labor Economics (IZA).

Mitchener, K. J. and I. W. McLean (1999). U.s. regional growth and convergence, 1880-1980. *The Journal of Economic History 59*(4), 1016–1042.

Moriceau, J.-M. (2011). *L'élevage sous l'Ancien Régime*. Sedes.

Ottaviano, G. I. P. (2001). Monopolistic competition, trade, and endogenous spatial fluctuations. *Regional Science and Urban Economics 31*(1), 51–77.

Rauch, J. E. (1993). Does History Matter Only When It Matters Little? The Case of City-Industry Location. *The Quarterly Journal of Economics 108*(3), 843–867.

Sands, T. and C. P. Higby (1949). France and the salt tax. *The Historian 11*(2), 145–165.

Slemrod, J., C. Gillitzer, et al. (2014). *Tax systems*. MIT Press Cambridge, MA.

Squicciarini, M. P. and N. Voigtländer (2015). Human capital and industrialization: Evidence from the age of enlightenment. *The Quarterly Journal of Economics 130*(4), 1825–1883.

Stokey, N. L. and S. Rebelo (1995). Growth effects of flat-rate taxes. *Journal of Political Economy 103*(3), 519–550.

Ufier, A. (2014). Quasi-experimental analysis on the effects of adoption of a value added tax. *Economic Inquiry 52*(4), 1364–1379.

Ufier, A. (2017). The effect of vats on government balance sheets. *International Tax and Public Finance 24*(6), 1141–1173.

Zagler, M. and G. Dürnecker (2003). Fiscal policy and economic growth. *Journal of Economic Surveys 17*(3), 397–418.

Appendix for "*Taxation with a Grain of Salt: The Long-Term Effect of Fiscal Policy on Local Development*"
(for online publication only)

T. Giommoni and G. Loumeau

A The institutional characteristics of the salt tax (1246-1945)

[In this section, we present the institutional characteristics of the salt tax focusing on the rational behind the existence of salt tax borders and discuss the reasons that explain their exact geographical location. For the sake of completeness, we sometimes repeat information already presented in Section 2.]

Figure A1 shows the full map of the salt tax, with rates in place in 1788. In the empirical analysis of the paper, we compare zones B-C-D (treatment) to zone A.

A.1 Pays de Grandes Gabelles (Zone A in Figure A1)

The *Pays de Grandes Gabelles* (lit. *Country of High Salt Tax*) correspond to a large region around Paris. There, a large tax rate was imposed such that the sale price of salt in the region was, on the average, nine to ten times the net cost of the salt. For instance, Beaulieu (1903) mentions that in Paris in 1662, the wholesale price of a given quantity of salt was 4 livres and 10 sous, while the price to the consumer was 42 livres, 4 sous, and 7 deniers. However, what made this tax particularly unpopular was its compulsory nature. The people in the *Grandes Gabelles* regions were forced to purchase a given amount of salt, and required to pay a very high tax upon it.

A.2 Quart-Bouillon (Zone B in Figure A1)

The *Quart-Bouillon* is a small region around Normandy, where salt was obtained by boiling salty water from salt marshes. The low tax rate area is located within the former *Duché de Normandie* which became part of the French kingdom in 1204.

Rational for the border placement: The tax border coincides with the border of the *Bailliage du Cotentin* (a sub-administrative jurisdiction within the former duchy of Normandy) which produced large quantities of salt from local salt marshes. This area famously includes the Mont-Saint-Michel salt marshes. Instead of paying a salt tax, 1/4 of the local salt production was ceased by the King. It was then sold throughout the kingdom.

A.3 Provinces Rédimées (Zone C in Figure A1)

The *Provinces Rédimées* also faced a much lower sale price of salt, but not due to the local availability of salt. Instead, the attachment to the French kingdom of the area in 1472 coincided with a moment of fiscal difficulty for the crown. In 1553, they redeemed themselves from paying a salt tax by paying the king a one time fee of 1,194,000 livres.

Rational for the border placement: The precise placement of the border between the *Provinces Rédimées* and the *Pays de Grandes Gabelles* is based on the border of the Duchy of Aquitaine when it first joined the French Kingdom in 1137 following the marriage of Alienor of Aquitaine and the French king. However, long before 1137 and until 1472, the exact placement of the border between Aquitaine and France continuously changed. The political and military instability of the area is a consequence of its topology (Kitamura and Lagerlöf, 2019). It coincides with what geologists call the *Seuil du Poitou*, i.e., where the *Paris* (Northeast) and *Aquitaine* (Southwest) sedimentary basins meet, and hence where we observe a gap between the ancient mountain ranges *Massif Armoricain* (Northwest) and the *Massif Central* (Southeast).

A.4 Pays de Salines (Zone D in Figure A1)

As indicated by its name, the *Pays de Salines* (lit. *Country of Salines*) is a region where salt is highly concentrated in the underground. Saline – a mixture of salt and water – naturally flows close to the surface.

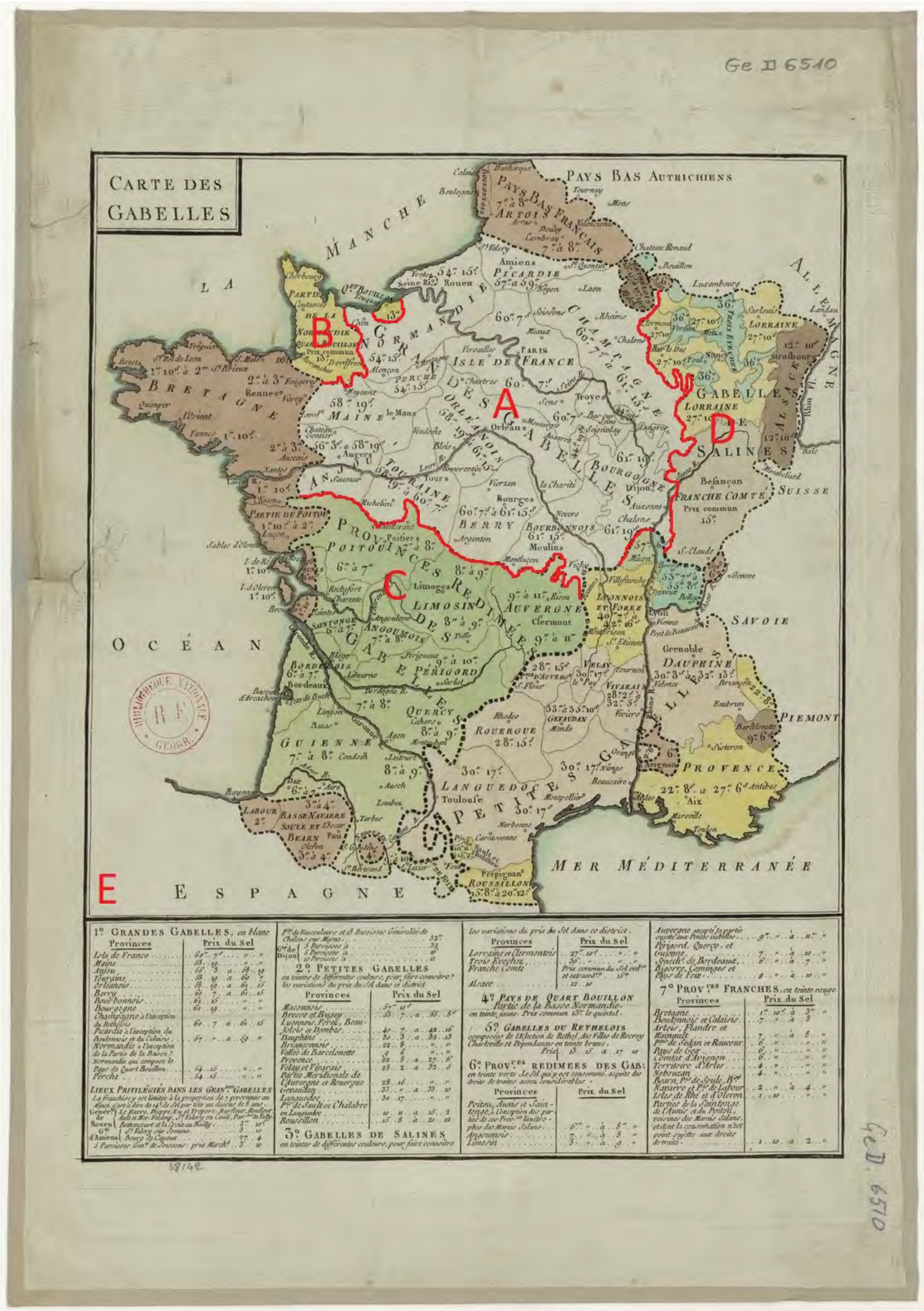
Rational for the border placement: The border between the *Pays de Salines* and the *Pays de Grandes Gabelles* contours the natural sources of saline around the current region of Jura close to the French-Swiss border.

A.5 Chronology of salt taxation in France (1246-1945)

Figure A2 presents key dates in the development of the salt tax system in France from the entry of the Duchy of Normandy in the Kingdom of France in 1204 to the abrogation of the uniform salt tax in 1945.

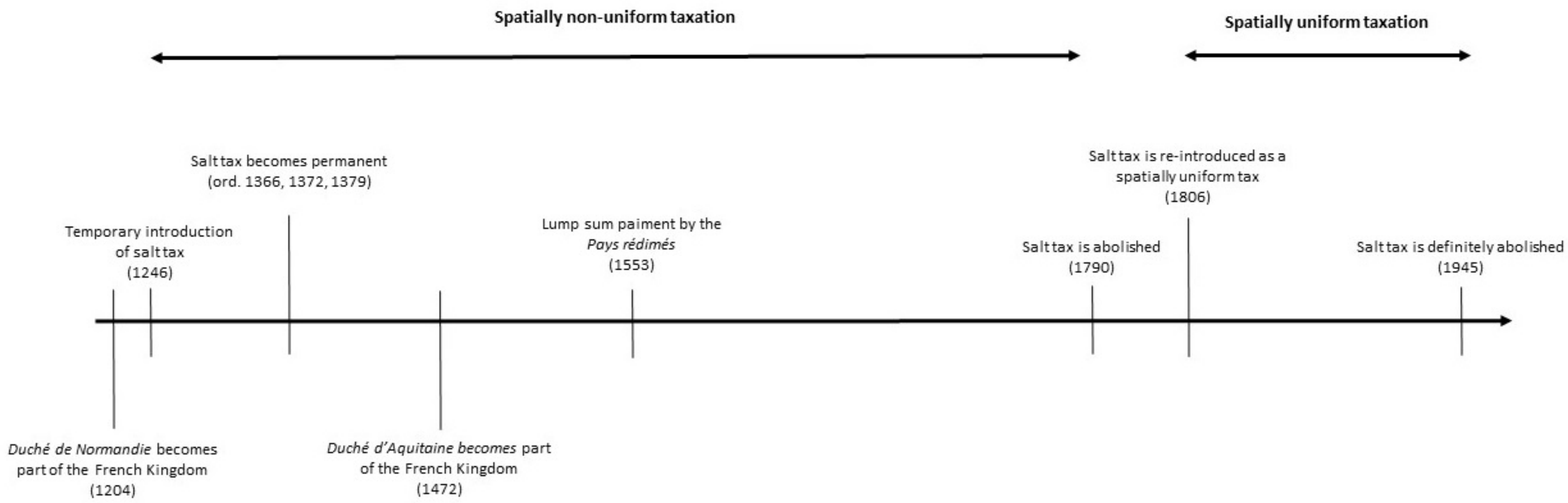
Figure A1: The French Salt Tax System

(end of *Ancien Régime*)



Source: National Library of France, BnF.

Figure A2: Chronology of salt taxation in France (1246-1945)



Source: Authors' own illustration.

B Supporting material

B.1 Tables

Table A1: Descriptive statistics

	Average value	**Standard deviation**	**N**
	(a) Municipality level		
Population density (2006)	3.458	1.133	7,179
Public firms (per km^2)	-1.684	.865	7,180
Private firms (per km^2)	.765	1.008	7,164
Population density (1876)	3.898	.693	7,185
Population density (1896)	3.793	.726	7,185
Population density (1911)	3.702	.753	7,185
Population density (1931)	3.532	.808	7,184
Population density (1954)	3.471	.860	7,180
Population density (1975)	3.358	1.024	7,181
Population density (1990)	3.399	1.106	7,181
Distance alt mines (in km)	44.488	21.792	7,185
Distance salt marshes (in km)	226.315	133.425	7,185
	(b) 1 km^2 cells level		
N. individuals	3.046	1.573	82,286
N. households	2.177	1.568	82,286
Av. income	9.934	.136	82,286
Total income	12.981	1.599	82,286
Fr. poor households	.140	.098	82,286
	(c) Arrondissement level		
Pop. density (1789) - local capital	1.492	.833	2,880
Pop. density (1801) - local capital	1.538	.786	2,880
Pop. density (1811) - local capital	1.609	.796	2,880
Pop. density (1821) - local capital	1.651	.781	2,880
Pop. density (1831) - local capital	1.701	.789	2,880
Pop. density (1836) - local capital	1.746	.805	2,880
N. newborns (per km^2)	-1.783	.889	2,880
N. deceased people (per km^2)	-1.868	.860	2,880
N. marriages (per km^2)	-3.046	.864	2,880

Notes: The table shows descriptive statistics computed using a bandwidth of 50 km. All the variables, except *Fr. poor households* are expressed in logarithm. The variables *Av. income* and *Total income* are expressed in Euros (in logarithms).

Table A2: Descriptive statistics: historical population data

	Average value	Standard deviation	N
	(a) Historical population density		
Population den. (1400)	.543	1.06	3,803
Population den. (1425)	.544	1.06	3,803
Population den. (1450)	.590	1.10	3,803
Population den. (1475)	.655	1.14	3,803
Population den. (1500)	.875	1.29	3,803
Population den. (1525)	1.16	1.48	3,803
Population den. (1550)	1.74	1.72	3,803
Population den. (1575)	2.63	1.91	3,803
Population den. (1600)	3.97	1.90	3,803
Population den. (1625)	5.02	1.77	3,803
Population den. (1650)	5.87	1.64	3,803
Population den. (1675)	6.49	1.51	3,803
Population den. (1700)	6.78	1.39	3,803
Population den. (1725)	6.96	1.30	3,803
Population den. (1750)	7.05	1.24	3,803
Population den. (1775)	7.14	1.19	3,803
Population den. (1800)	7.10	1.15	3,803
Population den. (1825)	7.11	1.13	3,803
Population den. (1850)	7.09	1.13	3,803
Population den. (1875)	7.05	1.16	3,803
Population den. (1900)	6.76	1.20	3,803
	(b) Historical migration inflow		
Migration inflow den. (1400)	.344	.776	3,803
Migration inflow den. (1425)	.344	.766	3,803
Migration inflow den. (1450)	.359	.773	3,803
Migration inflow den. (1475)	.372	.781	3,803
Migration inflow den. (1500)	.444	.855	3,803
Migration inflow den. (1525)	.589	1.00	3,803
Migration inflow den. (1550)	.961	1.26	3,803
Migration inflow den. (1575)	1.69	1.55	3,803
Migration inflow den. (1600)	3.01	1.67	3,803
Migration inflow den. (1625)	4.09	1.59	3,803
Migration inflow den. (1650)	4.91	1.43	3,803
Migration inflow den. (1675)	5.48	1.28	3,803
Migration inflow den. (1700)	5.69	1.13	3,803
Migration inflow den. (1725)	5.84	1.02	3,803
Migration inflow den. (1750)	5.90	.959	3,803
Migration inflow den. (1775)	6.01	.919	3,803
Migration inflow den. (1800)	6.05	.917	3,803
Migration inflow den. (1825)	5.95	.932	3,803
Migration inflow den. (1850)	5.80	.960	3,803
Migration inflow den. (1875)	5.73	1.03	3,803
Migration inflow den. (1900)	5.43	1.16	3,803

Notes: The table shows descriptive statistics for the historical data on municipal population and migration inflow, using a bandwidth of 25 km. Population density and migration inflow densities are expressed in logarithm.

Table A3: Impact on population density over time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(a) Municipal population density							
Reference year:	1876	1896	1911	1931	1954	1975	1990	2006
Treatment	0.165**	0.184**	0.210**	0.257***	0.218**	0.191	0.231*	0.296**
	(0.074)	(0.082)	(0.084)	(0.096)	(0.101)	(0.119)	(0.129)	(0.135)
N	1454	1396	1350	1377	1396	1426	1367	1322
Bandwidth	8.73	8.39	8.13	8.28	8.39	8.55	8.23	7.99

Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. "Municipal population density" is expressed in km^2 (in logarithm). The specification always includes salt borders fixed effects. The unit of analysis is the municipality. "Dep. var. mean" indicates the average value of the dependent variable. Robust standard error are included.

Table A4: DIFFERENCE-IN-DIFFERENCES ANALYSIS: HISTORICAL DATA (1400-1900)

	(1)	(2)
	(a) Municipal population density	
	Provinces Rédimées	Provinces de Salines
Treatment*Post	0.145***	0.163***
	(0.056)	(0.050)
N	24,780	34,440
Municipal FE	Yes	Yes
Department-year FE	Yes	Yes

Notes: The table shows the difference-in-differences analysis. The dependent variable is municipal population density (in logarithm). The analysis covers the time span 1400-1900, and the time units captures 25 years periods. "Treatment" is a dummy variable captuting the municipalities in the Provinces Rédimées (in column 1) and in the Provinces de Salines (in column 2). "Post" indicates the years after the introduction of the sal tax border, it captures the years after 1553 in column (1) and those after 1678 in column (2). The analysis of column (1) includes the municipalities around the border between Provinces Rédimées and Grande Gabelle, with a 25 km bandwidth. The analysis of column (2) includes the municipalities around the border between Provinces de Salines and Grande Gabelle, with a 25 km bandwidth. The specification always includes municipality, year and department-year fixed effects. Standard errors are clustered at the municipal level.

Table A5: Balancing tests of locational fundamentals

	(1)	(2)	(3)	(4)
Dep. var.	Limitations to soil fertility	Distance nearest river	High altitude	Connected to roman road network (ca. 117)
Treatment	0.008	-1018.661	-0.002	-0.031
	(0.020)	(2134.031)	(0.002)	(0.021)
N	2,236	2,905	1,404	3,001
Bandwidth	11.55	14.94	6.92	15.51

Notes: Limitations to soil fertility is measured as a function of: (i) nutrients availability, (ii) rooting conditions, (iii) oxygen availability, and (iv) toxicity. A higher value implies less fertile soil. *Source*: Harmonized World Soil Database is a 30 arc-second raster database.

Table A6: Balancing test of individual characteristics (before salt tax introduction)

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel a: Population composition and life expectancy					
Dep. var.	Aristocrats (share)	Female (share)	Life expectancy (no. years)	Life expectancy female (no. years)	Life expectancy male (no. years)	-
Treatment	-0.056	-0.066**	-3.128	-5.012*	-0.353	-
	(0.039)	(0.029)	(2.270)	(2.696)	(2.289)	-
N	708	651	562	531	713	-
Bandwidth	5.77	6.86	5.59	5.84	7.39	-
	Panel b: Marriage					
Dep. var.	Married (share)	Married female (share)	Married male (share)	Av. marriage age (no. years)	Av. marriage age female (no. years)	Av. marriage age male (no. years)
Treatment	-0.052	-0.018	-0.036	0.397	0.621	-0.453
	(0.037)	(0.019)	(0.027)	(0.957)	(0.775)	(0.986)
N	765	749	668	595	717	796
Bandwidth	8.41	8.76	7.44	6.64	8.62	9.15

Notes: The analysis focuses on the 50 years before the introduction of the salt tax and only studies Provinces Redimees and Provinces de Salines. Aristocrats, female, married, married female and married male are expressed as share of the total population.

Table A7: Fuzzy regression discontinuity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	(a) Long-term impact on population density and economic variables						
Dep. var.	N. individuals 1km^2 cells	N. households 1km^2 cells	Public firms (per km^2)	Private firms (per km^2)	Av. income 1km^2 cells	Tot. income 1km^2 cells	Fr. poor HH 1km^2 cells
Treatment	0.048***	0.055***	0.090*	0.080*	0.004***	0.050***	-0.001
	(0.014)	(0.014)	(0.048)	(0.043)	(0.001)	(0.015)	(0.001)
Bandwidth	11.6	11.9	8.14	10.7	16.3	11.3	10.4
Obs. bw.	23,883	24,341	1,350	1,752	31,767	23,302	21,635
Mean dep var	3.09	2.23	3.52	.805	9.93	13	.14
p-value 1st stage	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(b) Impact on municipal population density over time						
Reference year	1876	1896	1911	1931	1954	1999	2006
Treatment	0.051**	0.056**	0.065**	0.085**	0.071*	0.083*	0.090*
	(0.024)	(0.027)	(0.028)	(0.037)	(0.037)	(0.047)	(0.048)
Bandwidth	8.47	8.25	8.69	9.86	9.14	8.33	8.14
Obs. bw.	1,416	1,371	1,450	1,624	1,522	1,385	1,350
Mean dep var	3.9	3.8	3.72	3.58	3.52	3.47	3.52
p-value 1st stage	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The table shows instrumental variable estimates. The set of instruments adopted includes: distance to the closest salt marsh, distance to the closest salt mines and the quadratic transformations of these two variables. "Municipal population density" is expressed in km^2. All variables except the one in column (8), panel a, are expressed in logarithm. The specification always includes municipal coordinates, municipal administrative status fixed effects and altitude of the municipality. The unit of analysis is cells of 1 km^2 size in columns (2), (3), (6), (7) and (8) of panel a and it is municipalities elsewhere. The bandwidth adopted is computed according to Calonico et al. (2014). "Dep. var. mean" indicates the average value of the dependent variable. Robust standard error are included.

Table A8: Difference-in-Differences analysis: in-migration (1400-1900)

	(1)	(2)
	(a) Municipal inflow of migrants	
	Provinces Rédimées	Provinces de Salines
Treatment*Post	0.062*	0.220***
	(0.034)	(0.032)
Obs.	24,780	34,440
Municipal FE	Yes	Yes
Department-year FE	Yes	Yes

Notes: The table shows the difference-in-differences analysis. The dependent variable is municipal inflow of migrants expressed as a density (in logarithm). The analysis covers the time span 1400-1900, and the time units captures 25 years periods. "Treatment" is a dummy variable captuting the municipalities in the Provinces Rédimées (in column 1) and in the Provinces de Salines (in column 2). "Post" indicates the years after the introduction of the sal tax border, it captures the years after 1553 in column (1) and those after 1678 in column (2). The analysis of column (1) includes the municipalities around the border between Provinces Rédimées and Grande Gabelle, with a 25 km bandwidth. The analysis of column (2) includes the municipalities around the border between Provinces de Salines and Grande Gabelle, with a 25 km bandwidth. The specification always includes municipality, year and department-year fixed effects. Standard errors are clustered at the municipal level.

Table A9: MIGRATION FLOWS FROM HIGH TAX AREA TO LOW TAX AREA BEFORE AND AFTER THE INTRODUCTION OF THE SALT TAX (1400-1900)

	(1)	(2)
	Migration flows	Opened flows
Post	0.032***	0.003***
	(0.003)	(0.0003)
Obs.	28,894,208	28,894,208
Municipality of origin FE	Yes	Yes
Municipality of destination FE	Yes	Yes
Time trend	Yes	Yes

Notes: The table shows the event-study analysis. In column (1), the dependent variable is size of the municipality-to-municipality flow of migrants between the high and the low tax areas. In column (2), the dependent variable is a ijt-indexed indicator variable equal to one if at least one migrant moved between i and j in period t, subject to $i \in$ HTA and $j \in$ LTA. The analysis covers the time span 1400-1900. Because we aim at studying migration flows, the time units capture 50 years periods. "Post" indicates the years after the introduction of the salt tax border in the Provinces Rédimées (i.e., 1553). The analyses include municipalities around the border within a 25 km bandwidth. The specification always includes municipality of origin, municipality of destination fixed effects, as well as a time trend. Standard errors are clustered at the municipal level.

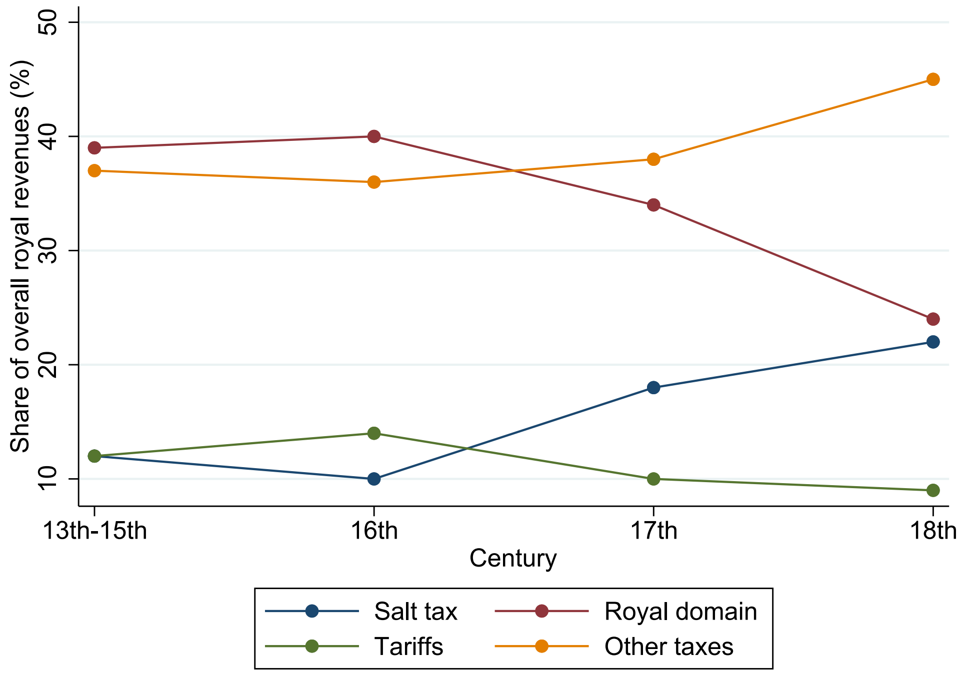
Table A10: Long term impact on agricultural activity and composition

	(1)	(2)	(3)
	(a) Municipal-level analysis (as of July 1st, 2022)		
Dep. var.	Density of agricultural firms (per km^2)	Share of agri. firms growing crops	Share of agri. firms raising livestock
Treatment	0.365***	-0.161***	0.202***
	(0.093)	(0.046)	(0.071)
N	1,071	2,058	1,891
Opt. bandwidth	6.37	12.64	12.32

Notes: The table shows non-parametric estimates following Calonico et al. (2014) under optimal bandwidth and polynomial order selection. Dependent variables are expressed in logarithm. Local firm information is provided by the French National Institute of Statistics and Economic Studies in the SIREN database. All variables are expressed in logarithm. The specification always includes salt borders fixed effects. Robust standard error are included.

B.2 Figures

Figure A3: Composition of the royal revenues in the *Ancien Régime* (1200-1800)



Source: Official royal public finance records from the National Library of France, BnF.

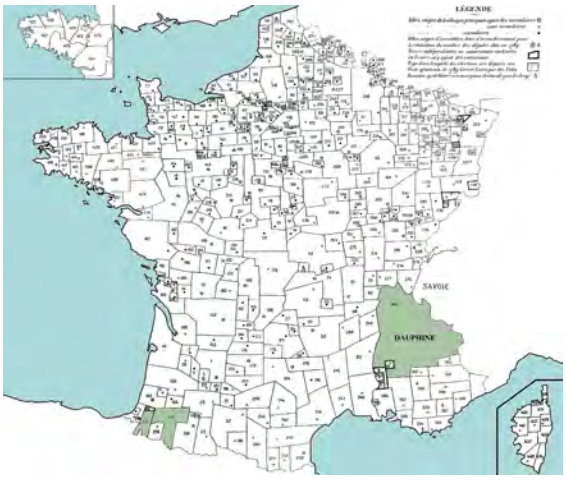
Figure A4: The royal salt storehouses (1709)

Notes: Squared shields indicate the location of a salt storehouses. Tours and Orléans are approximately 100km apart. *Source:* National Library of France, BnF.

Figure A5: ADMINISTRATIVE DIVISION OF THE *ANCIEN RÉGIME*

(a) Local fiscality: *Généralités*

(b) Local administration: *Baillages*



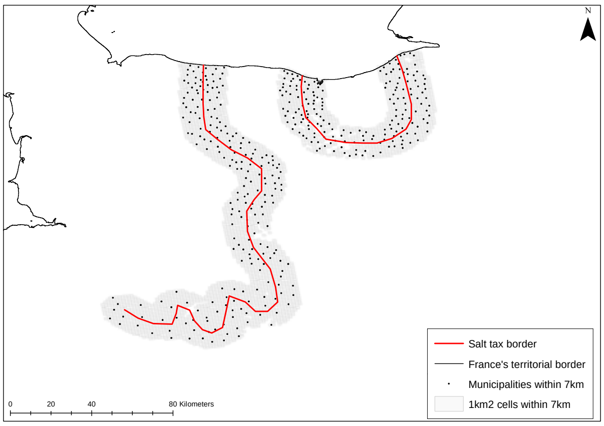
(c) Military and judiciary: *Provinces*

(d) Religious: *Diocese*

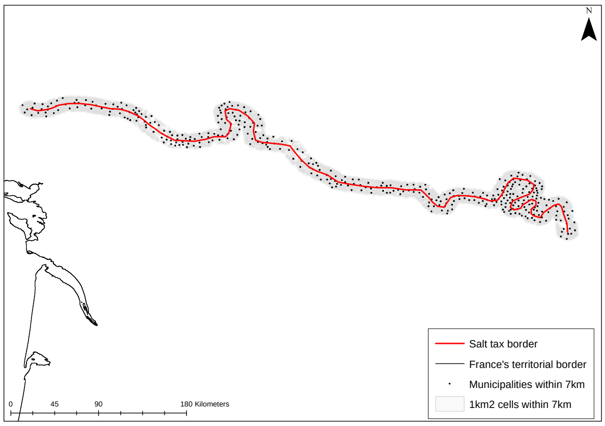
Source: National Library of France, BnF. Panel (d): author's own computation based on Grigoli and Maione-Downing (2013).

Figure A6: Municipalities and 1 km^2 grid cells within 7km of the salt tax borders

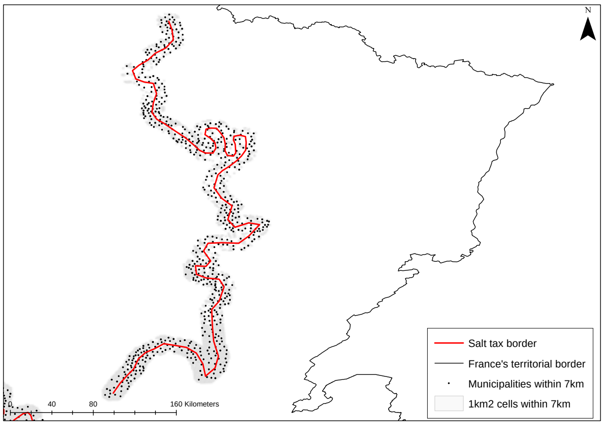
(a) Quart-Bouillon



(b) Provinces Rédimées

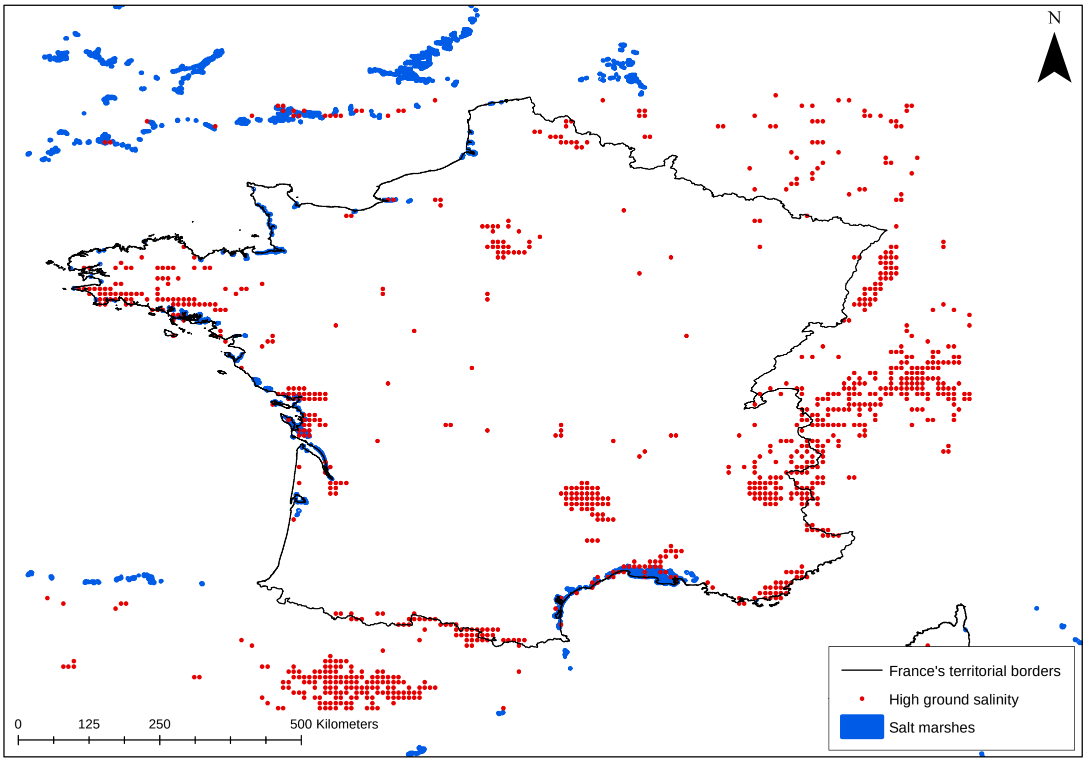


(c) Provinces de Salines



Notes: Illustration based on the authors' own geo-referencing of the salt tax borders, publicly available shapefiles of municipal boundaries, as well as the 2010 "données carroyées à 1km^2 sur la population" provided by the French National Institute of Statistics and Economic Studies (INSEE). A 7km bandwidth is in line with the optimal bandwidth derived following Calonico et al. (2014) across the different specifications in the empirical analysis below.

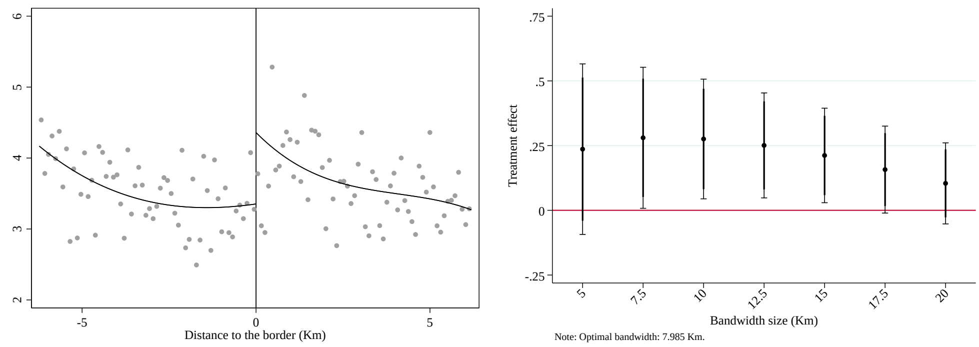
Figure A7: Natural sources of salt



Notes: High ground salinity information is obtained from the Harmonized World Soil Database (30 arc-second raster). We define as high, all grids with a value above 1 (1:low - 4:high). Salt marshes worldwide have been geo-localized by Mcowen et al. (2017).

Figure A8: Effect on municipal population density - 2006

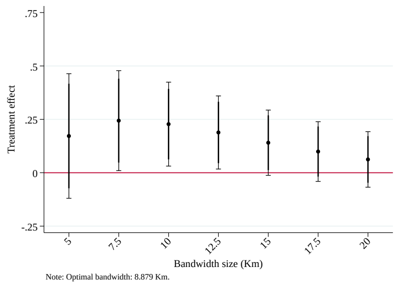
(a) RDD plot (b) Sensitivity analysis



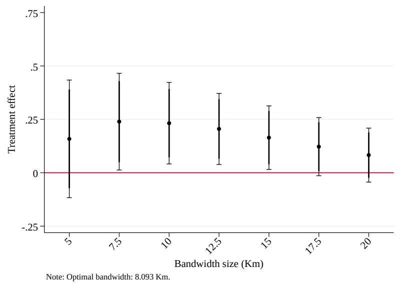
Notes: Left plot shows non-parametric estimates following Calonico et al. (2014), using a fourth order polynomial and optimal bandwidth. Right plot shows non-parametric estimates following Calonico et al. (2014) arbitrarily using bandwidth sizes from 5km to 20km, with 2.5km increments. For each coefficient, 95% (delimited by horizontal bars) and 90% (bold line) confidence intervals are shown. The dependent variable is municipal population density that refers to 2006 and is expressed in km^2 (in logarithm). The unit of analysis is municipality. The specification always includes salt border fixed effects.

Figure A9: Effect on economic indicators - sensitivity analysis

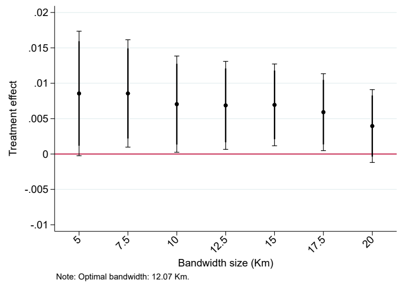
(a) Private firms (per km^2)



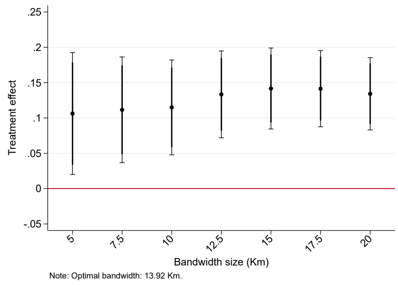
(b) Public estab. (per km^2)



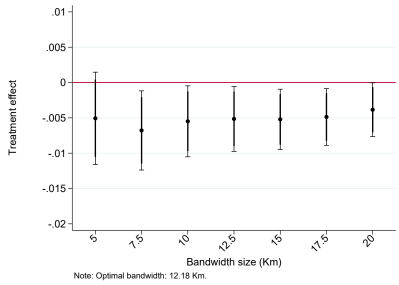
(c) Av. income (1 km^2 cells)



(d) Tot. income (1 km^2 cells)



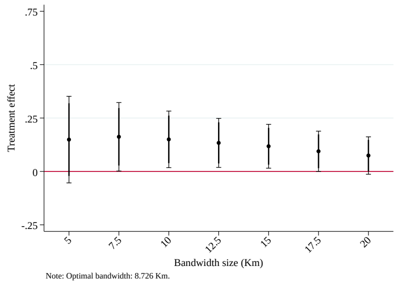
(e) Fr. poor HH (1 km^2 cells)

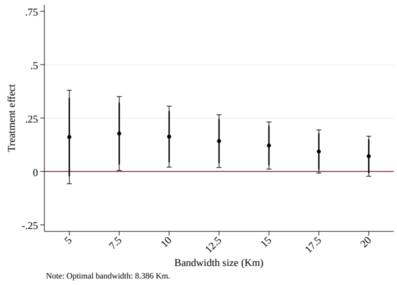


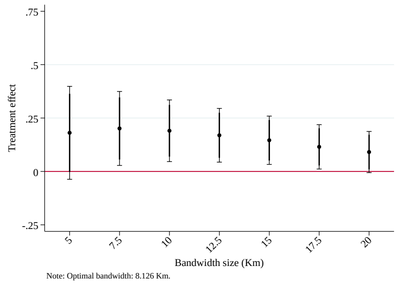
Notes: These plots show non-parametric estimates following Calonico et al. (2014) arbitrarily using bandwidth sizes from 5km to 20km, with 2.5km increments. For each coefficient, 95% (delimited by horizontal bars) and 90% (bold line) confidence intervals are shown. All the dependent variables are expressed in logarithm. The unit of analysis is municipality in panels a and b and cells of 1 km^2 size in panels c, d and e. The specification always includes salt border fixed effects and, in panels c, d and e, also municipal coordinates and residential area.

Figure A10: Effect on municipal population density - sensitivity analysis

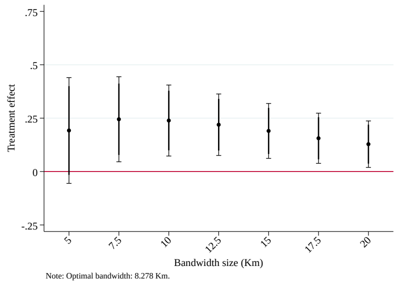
(a) Population density 1876 (b) Population density 1896 (c) Population density 1911

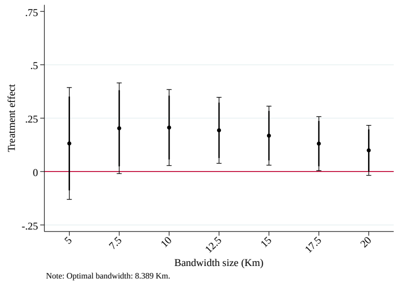


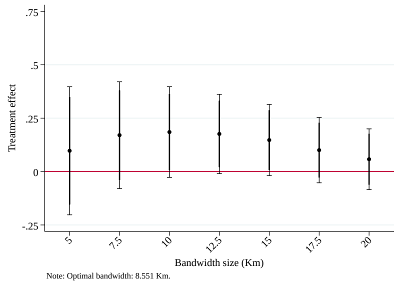




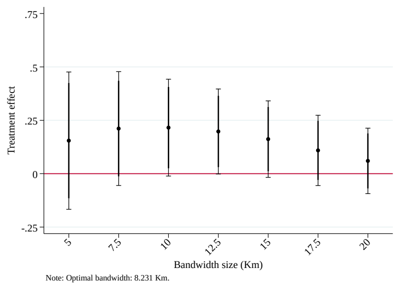
(d) Population density 1931 (e) Population density 1954 (f) Population density 1975

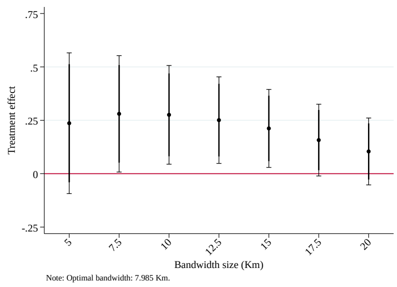






(g) Population density 1990 (h) Population density 2006

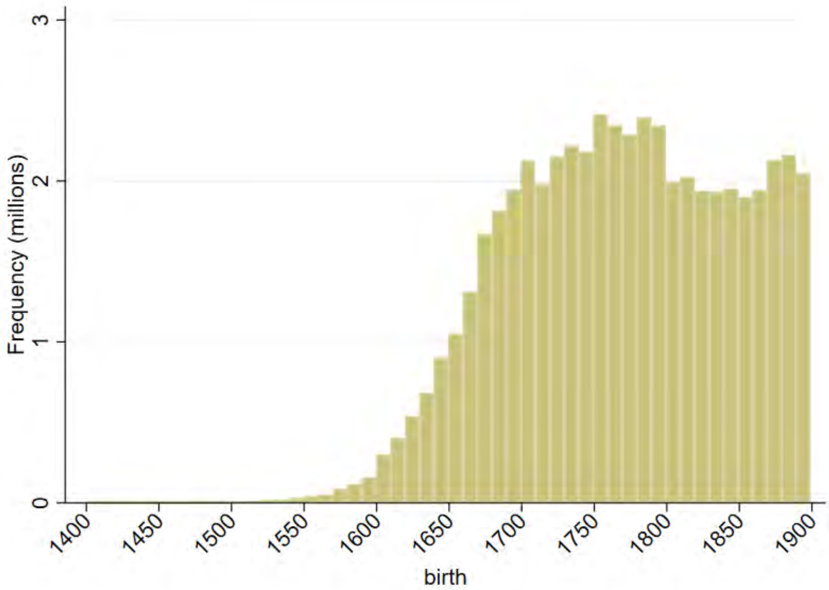




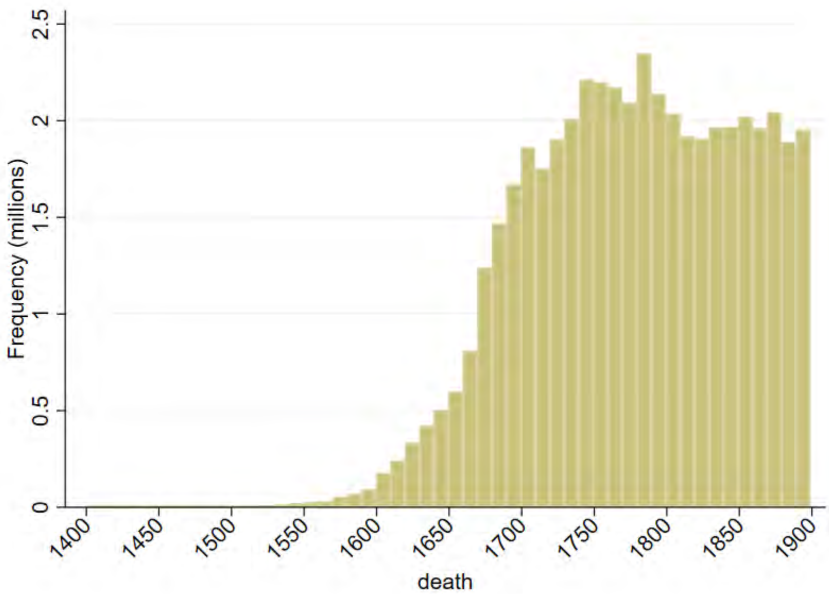
Notes: These plots show non-parametric estimates following Calonico et al. (2014) arbitrarily using bandwidth sizes from 5km to 20km, with 2.5km increments. For each coefficient, 95% (delimited by horizontal bars) and 90% (bold line) confidence intervals are shown. The dependent variables are expressed in km^2 (in logarithm) and the unit of analysis is municipality. The specification always includes salt border fixed effects.

Figure A11: Distribution of birth and death dates

(a) Dates of birth



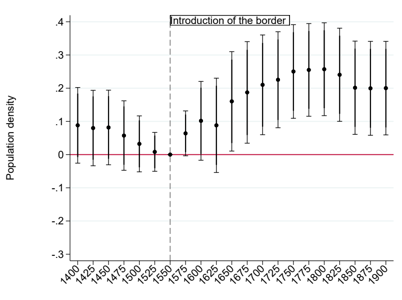
(b) Dates of death



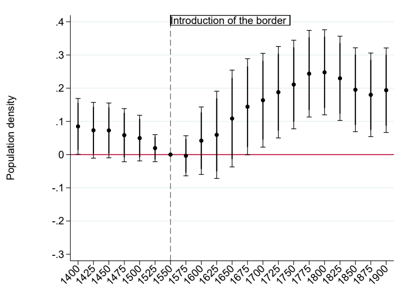
Notes: The figures show the distribution of individuals by year of birth (panel a) or year of death (panel b).

Figure A12: Effect on municipal population density 1400-1900 - Age groups

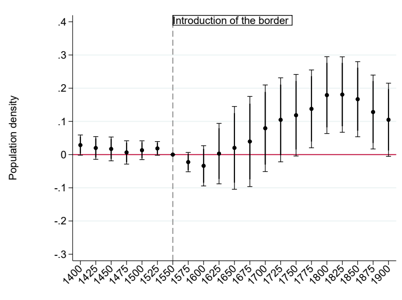
(a) Provinces Rédimées: young (1-16)



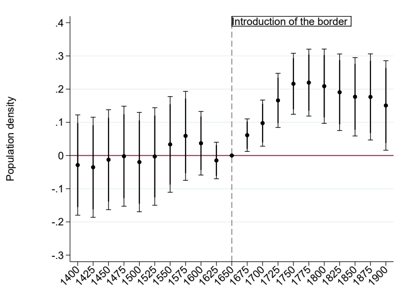
(a) Provinces Rédimées: adult (17-50)



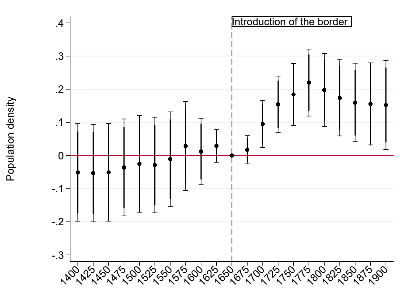
(a) Provinces Rédimées: senior (above 50)



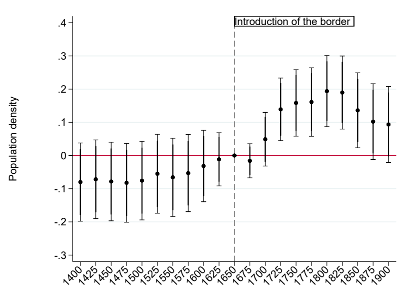
(b) Provinces de Salines: young (1-16)



(b) Provinces de Salines: adult (17-50)



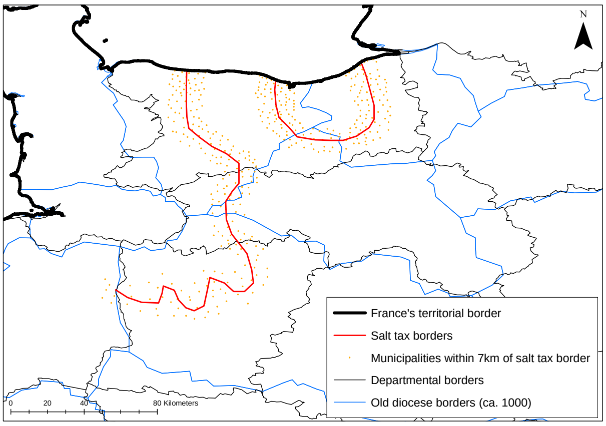
(b) Provinces de Salines: senior (above 50)



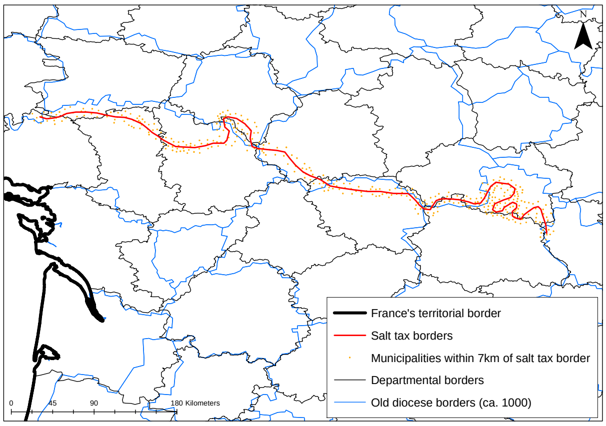
Notes: These plots show the difference-in-differences estimates of model 2 comparing municipalities in the LTA and HTA areas. The dependent variable is municipal population density (expressed in logs) aggregated in periods of 25 years. The specification always includes municipal and department-year fixed effects. This figures show the analyses dividing the sample of individuals by age group.

Figure A13: Historical and contemporary local borders around the salt tax borders

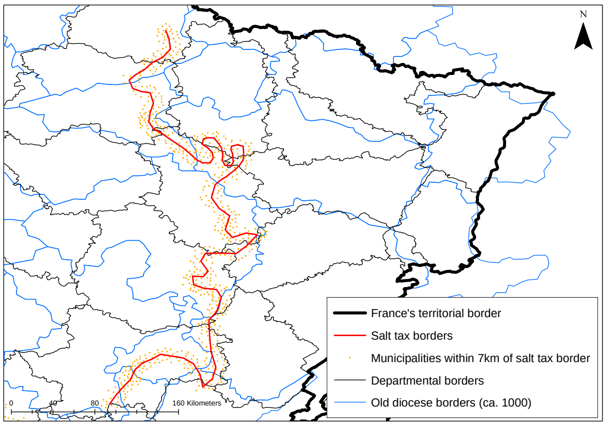
(a) Quart-Bouillon



(b) Provinces Rédimées

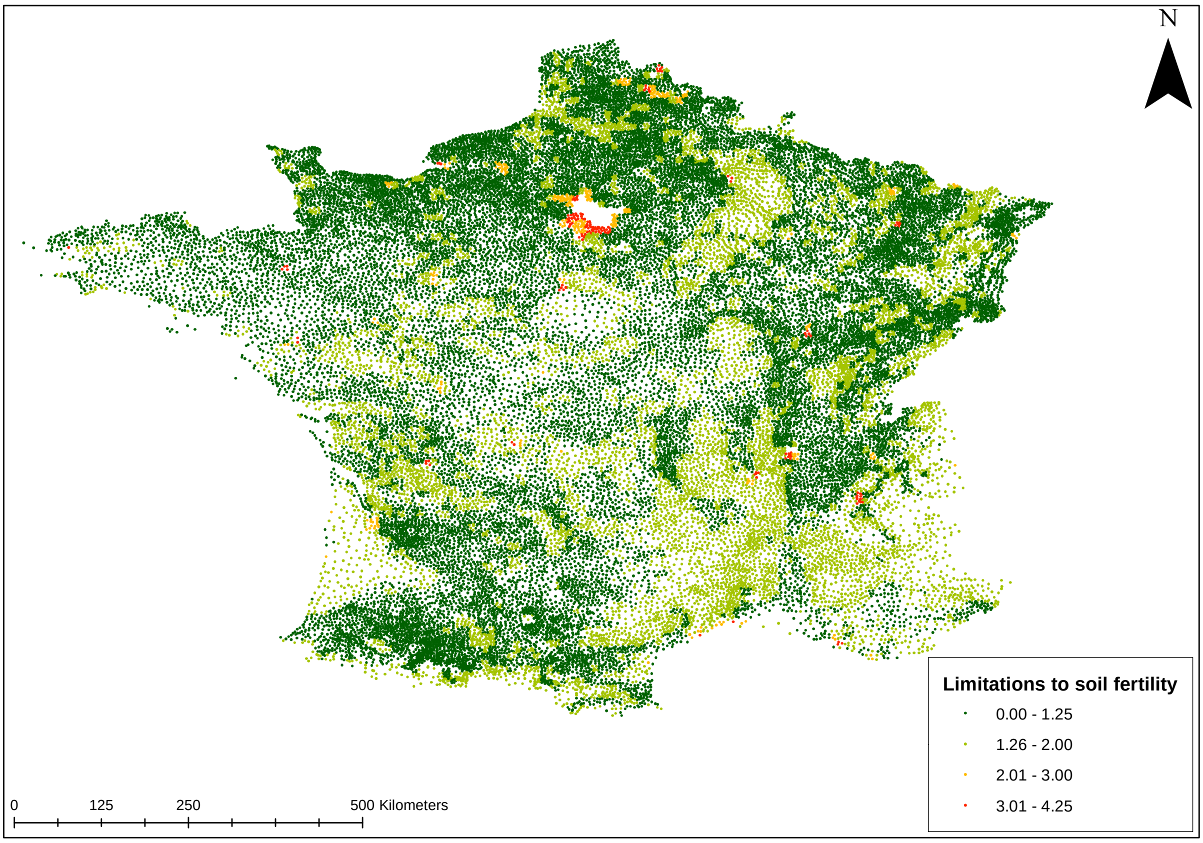


(c) Provinces de Salines



Notes: Illustration based on the authors' own geo-referencing of the salt tax borders, as publicly available shapefiles of municipal centroids, as well as shapefiles on departmental and old diocese boundaries (Grigoli and Maione-Downing, 2013). A 7km bandwidth is in line with the optimal bandwidth derived following Calonico et al. (2014) across the different specifications in the empirical analysis.

Figure A14: Soil fertility



Notes: Limitations to soil fertility is measured as a function of: (i) nutrients availability, (ii) rooting conditions, (iii) oxygen availability, and (iv) toxicity. A higher value implies less fertile soil. *Source*: Harmonized World Soil Database is a 30 arc-second raster database.

Figure A15: Geographic fundamentals

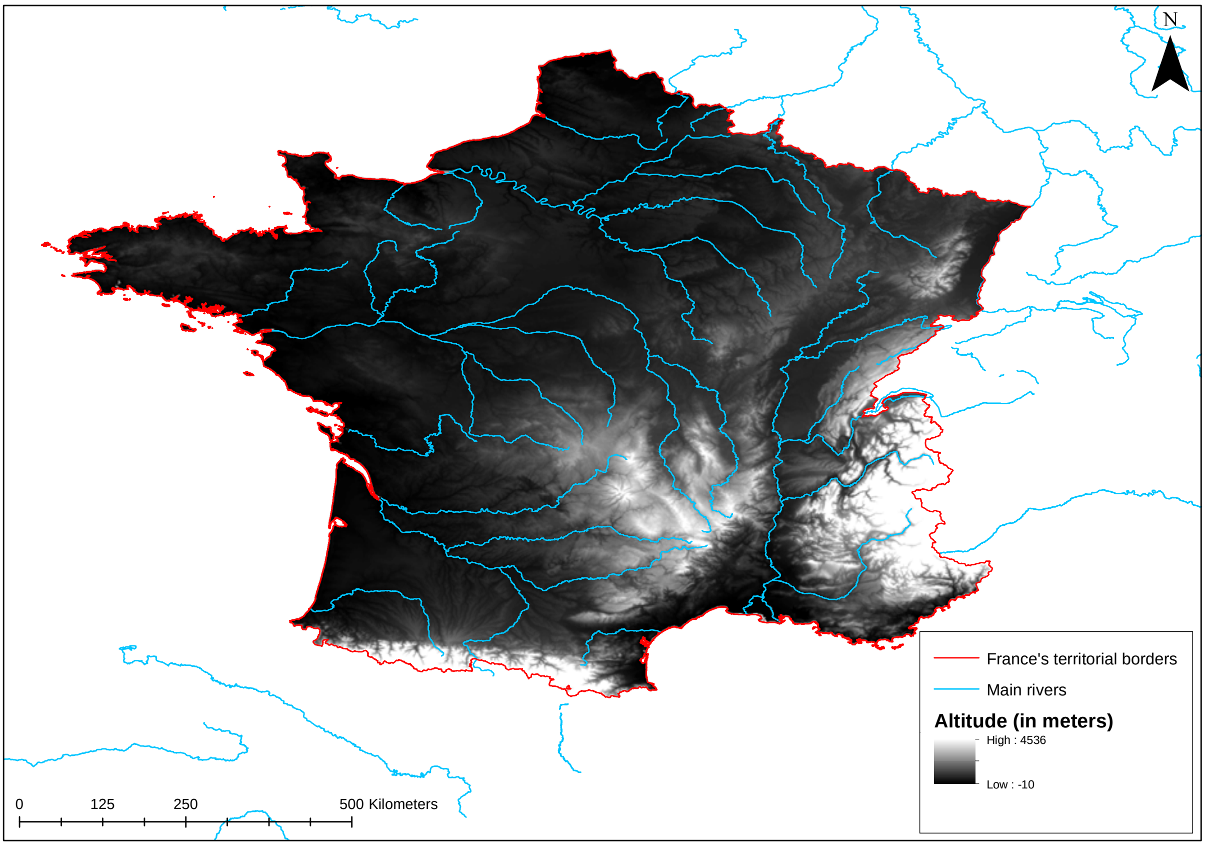
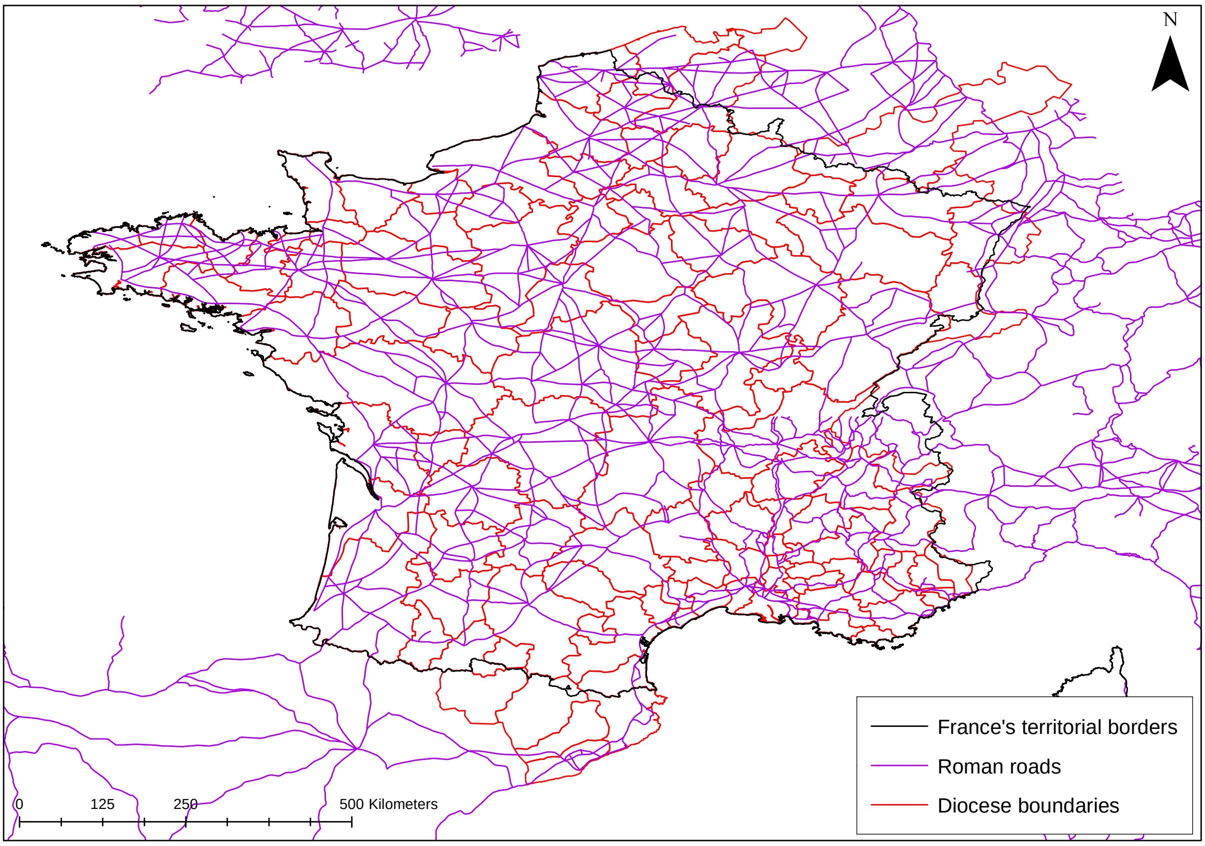


Figure A16: Historical covariates



Notes: Geo-localized data on diocese boundaries ca. 1000 are obtained from Grigoli and Maione-Downing (2013). Geo-localized information of the placement of roman roads ca. 117 were made available by McCormick et al. (2013).