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The value of terroir: A historical analysis of Bordeaux and Champagne, the world's first geographical indications

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The Value of Terroir. A historical analysis of Bordeaux and Champagne, the world's first geographical indications

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The Value of Terroir.
A historical analysis of Bordeaux and Champagne,
the world's first geographical indications

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Abstract

Previous studies on the value of terroir, or more generally geographical indications (GI), used hedonic techniques. We use historical data and exploit temporal and geographical variations in the introduction of wine GIs in early twentieth century France to study the impact on the price of specific wines in the years and decades following their introduction. We find large effects of GIs on prices of some Champagne wines, but no significant impact on Bordeaux or other Champagne wines. (JEL Classifications: C21, L51, L66, N53, Q11, Q18)

Keywords: Treatment effects, Appellations, European agriculture, regulation, wine history.

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1. Introduction

In 1776, Adam Smith wrote: *“The vine is more affected by the difference of soils than any other fruit tree. From some it derives a flavour which no culture or management can equal, it is supposed, upon any other. This flavour, real or imaginary, is sometimes peculiar to the produce of a few vineyards; sometimes it extends through the greater part of a small district, and sometimes through a considerable part of a large province.”*¹ Many wine producers and consumers across the globe, although they may not share Adam Smith’s more broader economic philosophy, will agree with him on this issue. Land prices in famous wine producing regions seem to support this argument as well. For example, in the “Champagne AOC”, i.e. the area that is officially delineated as the location for vineyards for producing Champagne wines, land prices are worth on average one million euro per hectare, while just next door (in the non-AOC area) vineyard land is worth on average only 13,000 euro per hectare (Agreste, 2017).

However, recent studies have challenged this argument. A set of empirical analyses over the past decade try to answer the question “Does Terroir Matter?” (Gergaud and Ginsburgh, 2008) or “What is the Value of Terroir?” (Cross et al., 2011). These papers and related studies by Ashenfelter and colleagues find mixed effects: Gergaud and Ginsburgh (2008) and Cross et al. (2011) find no effect of terroir on wine prices while Ashenfelter and Storchman (2010) and Gergaud et al. (2017) do find a positive effect.

Previous studies have used hedonic techniques where wine prices were regressed on indicators of the physical quality of “terroir” (such as type of soil, slope, ...) to explain variations

¹ Edwin Cannan (ed.), 5th ed. London 1904, Book 1, Chap XI, p. 219.

in prices.² The studies typically consider short and recent periods in time. In this paper, we use a different approach. We use historical data from sixty years (from 1875 to 1935) to analyse how the introduction of regulations that aim to formally establish a link between product quality and production location (*terroir*) affect the price of the wine. More specifically, we study how the introduction of wine geographical indications or “Appellations of Origin” (*Appellations d’Origine*–AO) in early twentieth century France influenced the price of specific wines (Champagne and Bordeaux) in the years and decades following their introduction. More specifically, we exploit the progressive geographic introduction of AOs in a difference-in-differences strategy to identify the impact of AOs on wine prices.

Our analysis shows large positive effects of the introduction of the AO regulations on prices of some wines but not on other wines. We estimate a price increase of more than 100 percent for some wines in the Champagne region, but no effects for wines of the Bordeaux region. In the last section, we present hypotheses to explain these heterogeneous results.

These results are relevant beyond the wine sector. For many other products one has tried to link product quality (perceptions) to the location of their production—as reflected in the rapid spread of geographical indications (GIs) throughout the world including the emerging economies

² These hedonic studies build on a long history of quantitative studies on the characteristics influencing variations in prices (Rosen, 1974; Waugh, 1928). The hedonic studies of wine prices have not only analyzed the impact of “value of terroir” but also a variety of other factors, such as the reliability of expert opinion, the role of weather variables, soil characteristics, etc on wine prices and quality. Examples include studies on wine from Australia (Byron and Ashenfelter, 1995; Oczkowski, 1994; Schamel and Anderson, 2003), France (Figuat and Cardebat, 2004; Combris et al., 1997, 2000; Landon and Smith, 1998; Lecocq and Visser, 2006), Israel (Golan and Shalit, 1993), Italy (Corsi and Ashenfelter, 2001), Germany (Ashenfelter and Storchmann, 2006; Schamel, 2003 and 2009), Spain (Angulo et al., 2000), Sweden (Nerlove, 1995) and the United States (Costanigro et al., 2007). See Storchmann (2012), Estrella Orego et al. (2012), Thrane (2004), Oczkowski and Doucouliagos (2015) and Unwin (1999) for reviews. Hedonic studies have also analyzed the impact of geographical indications on other commodities (e.g., Loureiro and McCluskey, 2000).

such as China, India or Mexico (Giovannucci et al., 2009; Vandecandelaere et al., 2018). GIs are an important issue in marketing (by signaling particular aspects of the product), in economics (by presumably reducing asymmetric information), and in trade negotiations. GIs have become a very important issue and source of conflict in trade negotiations. Some consider GIs as an important instrument to solve information problems in domestic and international trade. Others consider GIs mostly as protectionist instruments (Barham, 2003; Josling, 2006). The increasing importance of GIs and in trade and in trade conflicts have led to what Josling (2006) described as a “*war on terroir*”.³ The intensity of these conflicts presumes that the GIs have great value in creating or protecting rents. As we will show in this paper, this assumption may not always be justified.

The remainder of this paper is organized as follows: section 2 presents the creation of AO and the historical context in which the regional boundaries of wine Appellations were established at the beginning of the twentieth century in France. Section 3 describes our main data set and illustrates some descriptive statistics. Section 4 describes the empirical strategy. In section 5, we present and discuss our results.

2. Historical Background

“No production of luxury in France is subject today to such control than fine wines and brand-spirits. Each of the elements of the production (soil, grape varieties, cultivation methods) has been defined and imposed on producers in order to get all the quality required by the appellation. And this control has not been imposed on producers, but claimed by them.”
Joseph Capus, 1947

³ GIs were an important issue for the ratification of the EU-Canada Comprehensive Trade and Economic Agreement (CETA), and they are being debated in the ongoing negotiations on the Transatlantic Trade and Investment Partnership (TTIP) with the United States. For wines, more multilateral agreements exist, such as the 2006 Agreement between the United States and the European Community on Trade in Wine (Deconinck et al., 2015).

Today, there are over several thousands of Geographical Indications (GIs) in the world, institutions which link a product through its “terroir” through government regulation.⁴ While the link between the quality of specific foods and wines and the location of their production goes back thousands of years, the roots of much of the current GI regulations are more recent, and in particular the regulatory basis of the system of *Appellations d’Origine* (AO) lies in the early twentieth century (Meloni and Swinnen, 2013). In the second half of the nineteenth century, many French vineyards were destroyed by the invasion of *Phylloxera*, and France turned from the world’s largest exporter of wine to the world’s largest importer of wine. It took several decades to find a cure and for French vineyards to recover. By the beginning of the twentieth century, the combination of large wine imports and the recovery of French wine production led to an oversupply crisis and rapidly falling wine prices (Simpson, 2011).

The crisis also induced imitations of brand-name wines to capture higher-value markets. Examples of wine imitations were “false Champagne” wines or “false Bordeaux” wines, labelled and sold as Champagne or Bordeaux but produced in other parts of France (Augé-Laribé, 1950; Stanziani, 2004).⁵

⁴ In 2009, Giovannucci et al. (2009) estimate that there were more than 10,000 GIs in the world with an estimated trade value of more than 50 billion USD. Currently, in the EU there are approximately 3,000 GIs for wine and another 2,000 for food products (DOOR "Database Of Origin & Registration" database for foodstuffs and E-Bacchus database for wine, 2018).

⁵ Another “quality problem” were adulterations (to compete with cheap wine imports). Examples of wine adulterations included using wine by-products to maximum capacity (e.g., by adding water and sugar to grape skins, the *piquettes*), producing wine from dried grapes instead of fresh ones, mixing Spanish or Algerian wines with French table wines in order to increase the alcohol content, or adding plaster or coloring additives (e.g., sulfuric or muriatic acids) in order to correct flawed wines. This resulted in several laws in 1907 that defined wine, imposed the notification of annual production levels and forbade the addition of water and sugar in wines (JORF, 1907a; JORF, 1907b; JORF, 1907c; Stanziani, 2004).

This resulted in major protests of wine producers and sellers from the original wine areas and ultimately in a series of laws to protect the interests of “quality” wine producers by linking the “quality” of the wine to its production region (the ‘*terroir*’) and the traditional way of producing wine: the system of *Appellations d’Origine* (AO) (Meloni and Swinnen, 2013, 2018).⁶

The first regulations, between 1908 and 1911, established the official geographic boundaries (*Appellations d’Origine*–AO) of four wines:⁷ the wine areas of Bordeaux (a red wine produced in the Gironde department in south west France), of Champagne (a sparkling white wine produced in north east France, mainly in the Marne and Aube departments), of Banyuls (a sweet dessert wine produced in south west France) and of Clairette de Die (a sparkling white wine produced in south east France) (see Table 1 and Figure 1).⁸ These first AOs were thus from different parts of France but all four areas and their wines had a long history of quality wines.⁹

⁶ France also introduced high tariffs on wine and grape imports from Italy, Spain and Greece, effectively stopping the wine (and grapes) imports from those countries from 1890s onwards (Meloni and Swinnen, 2017; Pinilla and Serrano, 2008).

⁷ The regional boundaries of two other non-wine regions were delimited: Armagnac and Cognac. These regions are not taken into account in our analysis as they are both French brandies (not wines) located in south west France and made by distilling white wine to produce a spirit (“*eau de vie*”).

⁸ The same procedure was followed for the delimitation of these Appellation of Origins. A local commission delimited the areas that could claim a protected geographical name based on the concept of “local and constant practices” (“*usages locaux constants*”) (Article 1, JORF, 1908). The Cabinet of the Minister of Agriculture, with the approval of the Council of State (*Conseil d’État*), a judicial body in Paris, accepted the conclusions of the local commission and issued decree laws establishing regional appellations (Loubère, 1978, p. 315). These regional AOs were established through four successive decree laws: Champagne (JORF, 1909a), Banyuls (JORF, 1909b), Clairette de Die (JORF, 1910) and Bordeaux (JORF, 1911a).

⁹ For instance, Bordeaux and Clairette de Die were known and praised since the Roman times (the latter was referred to as “Clairette de Dea Augusta”) and the Champagne area was producing sparkling wine since the early Medieval period (Bonal, 1984; Unwin, 1991, p. 257; Vincens et al., 1911; Wolikow, 2009). In 1936, Banyuls obtained one of the early Appellations of Controlled Origin (*Appellations d’Origine Contrôlées*–AOC) together with other sweet wines produced in the Midi wine region, e.g. Maury, Rivesaltes, Côtes d’Agly and Côtes de Haut-Roussillon (JORF, 1936).

Banyuls AO and Clairette de Die AO were small wine areas (around 1,300 hectares and 1,500 hectares respectively) and they exported very little. Bordeaux AO (140,000 hectares) and Champagne AO (15,000 hectares) were much larger and both had important export markets, especially to England, Belgium, and the United States.

The delineation of the Champagne and Bordeaux terroirs were very controversial and the subject of intense lobbying, and in the case of Champagne ultimately resulted in two Champagne AOs. In the Champagne region winegrowers from various departments (*départements*—the French regional administrative units) wanted to be part of the AO. But there was a strong division of interests between two groups. The first group consisted of the large Champagne houses (such as Veuve Clicquot or Moët&Chandon) who were located in the Marne department and who bought wine and grapes exclusively from wine producers and vineyards within the Marne and Aisne departments; and the producers in these (Marne and Aisne) departments. The second group was mostly smaller merchants who bought wine and grapes also from other departments in the region, such as the Aube and Haute-Marne departments, and the winegrowers of these other departments.

The first group with the large Marne Champagne houses initially successfully lobbied the French government to restrict the Champagne AO (decided in 1908) to the Marne and the Aisne departments only (Table 2). This, in combination with poor harvests in the following years, triggered even stronger lobbying by wine producers and traders in the excluded departments, who argued that their wine was of equal quality. In 1911, the government gave in and created two “zones” in the Champagne AO: the original (1908) Champagne AO which encompassed the Marne and the Aisne departments was now called “*Champagne AO Zone 1*” and a second AO called “*Champagne AO Zone 2*” which included the Aube, Haute-Marne and Seine-et-Marne

departments (see Meloni and Swinnen 2018; Simpson 2011; and Unwin 1991 for more details). However, the lobbying by the Zone 2 producers and traders continued—for reasons which will become clear through our analysis—and in 1927 the government decided to remove the Zone 1 and Zone 2 distinction (JORF, 1927). The 1927 created one “Champagne AO” which included all the departments: Marne, Aisne, Aube, Haute-Marne and Seine-et-Marne (Chappaz, 1951; Wolikow, 2009).

In the Bordeaux region, there were also conflicts among winegrowers and traders from different departments. The initial proposal (in 1909) was to include three departments in the southwest of France in the Bordeaux AO: Gironde, Dordogne and Lot-et-Garonne. However, fierce protests from wine producers inside the Gironde department resulted in the exclusion of the other two departments. The official Bordeaux AO as implemented in 1911 (and unchanged since) was restricted to the Gironde department (Roudié, 1988; Simpson, 2011).

The delineation of the Banyuls AO and Clairette de Die AO were less controversial. These two AOs are small and in fact considerably smaller than the departments they are in: Banyuls AO covers only 3% of the department Pyrénées-Orientales and Clairette de Die AO only 9% of the department Drôme. The small department coverage of the AO makes it hard to measure the effect since wine prices are only available at the department level and not at the AO level. For this reason, we could not include the Banyuls AO and Clairette de Die AO in our analysis. Our analysis thus includes data from three AOs: the Champagne AO Zone 1, the Champagne AO Zone 2, and the Bordeaux AO. For each of these the boundaries of the AO coincide with the boundaries of department(s).

3. Data and Descriptive Statistics

We collect annual department-level data from the *Annuaire Statistique de la France*—the Statistical Yearbook of France—and the *Statistique Agricole Annuelle*—the Annual Agricultural Statistics.¹⁰ The departments (*départements*) are administrative divisions.¹¹ The data set includes 84 wine producing departments throughout our period of observation. We use 60 years of annual data: from 1875, the first year available in the *Annuaire Statistique*, until 1935, when a new set of government regulations introduced both additional requirements for the existing AOs and introduced a series of new AOs in different regions in France (Humbert, 2011; JORF, 1935 and 1936).¹² Since the initial AOs were introduced between 1908 and 1911, our data cover approximately 35 years before and 25 years after the introduction of the AOs in Bordeaux and Champagne.

The explanatory variables include total wine production per departments (in hectoliters, hl), the vineyard surface area (the cultivated area under vines in hectares, ha), the wine yield (calculated as the number of hectoliters produced per hectare) and the average price of wine in

¹⁰ The *Annuaire Statistique* was published each year (from 1878 to 1936) and contained statistics of the previous year, and reported tables of the *Statistique Agricole Annuelle*. However, there are some exceptions, as some *Annales* were published two or three years after the previous one (this was the case during times of war) (*Statistique Agricole Annuelle*, 1886; *Statistique Générale de la France*, 1878; 1901).

¹¹ In 1790, the departments were created in France by the National Constituent Assembly, the legislative body established during the 1789 French Revolution.

¹² A 1935 law created the Appellations of Controlled Origin (*Appellations d'Origine Contrôlées*—AOC) and the National Committee for Appellations of Origin (renamed INAO in 1947), a government branch established to administer the AOC process for “high quality” wines. This law combined several earlier regulations: it restricted production not only to specific regional origins (through delimitation of specific areas) but also to specific production criteria such as grape variety, minimum alcohol content, and maximum vineyard yields. The wine producers were now also obliged to respect specific production criteria in order to produce AOC wines, adding “controlled” to the “appellation of origin” concept (Article 19, JORF, 1935; Humbert, 2011; Loubère, 1990; Stanziari, 2004).

francs per hectoliter¹³ (which we deflated with the Consumer Price Index (1914=100) from Mitchell (1998) for our analysis)¹⁴ (see Figures 2 and 3 for an illustration of the wine variables present in the *Annuaire Statistique* and Table 3 for summary statistics).¹⁵

Figure 4.1 shows the price gap between AO areas and control areas (i.e., non-AO areas) before and after the introduction of the AOs (represented by the vertical lines). Figure 4.2 shows the ratio of AO and non-AO average prices, and Figure 4.3 shows the same ratio but with as control only the frontier departments, i.e. departments bordering the AO areas.¹⁶

These figures suggest that the price difference was small (and sometimes negative) before the AO introduction. After the AO introduction, the price difference increased strongly. The average price was around 22% before while shifting to 107% after the introduction of AO (Table 4). This result still remains when only considering the frontier departments (Figure 4.3).

Hence, the AO-impact appears strong. However, there are two caveats. One is that there is significant volatility in the price gap. The “AO premium” fluctuates between 10% to more than 300% over the almost thirty year period. During our observation period, major historical events marked the wine industry: the *Phylloxera* crisis, the World War I (1914–18) and the Great Depression (1929–1939). These events marked on Figure 4.1 may explained in part the volatility of the price gap. The second is that the effect differs strongly among the AOs. The latter is

¹³ The price per hectolitre is the sales price collected on the basis of fiscal and accompanying documents for wines.

¹⁴ Even if during World War I food prices were heavily regulated, we do not have a better deflator.

¹⁵ The data was extracted from two main sections: one section on agricultural production, and another one on the French administration and its public finances. The location of the sections changed over time thorough the *Annuaire Statistique*. For the early years, the wine variables (as wine production and wine prices) were extracted from «Agriculture» in section XIV. From 1901 onwards, the wine variables were extracted from: «3^e Partie Production, Mouvement Economique–3A.Agriculture, Forêts Pêche–Tableau 1.Production des vins par département».

¹⁶ The subsample of frontier departments includes 20 departments out of a total of 84 departments.

illustrated in Figures 5.1 through 5.4. These Figures and Table 4 suggest that there was only a strong AO-effect in “Champagne Zone 1”. In this case, the average price difference was large before (around 68%) but was amplified to 272% after the introduction of AO. In “Champagne Zone 2” we also observe a price increase, but it is more modest. Prior to the introduction of AO, wine prices were slightly below that of all other wines, and reached a price difference of 26% on average after the introduction. Interestingly, Figure 5.3 also suggest that the AO-effect in “Champagne Zone 1” falls to its lowest level after 1927 when the Zone 1 and Zone 2 AOs are merged into a single “Champagne AO”.

Interestingly, the introduction of the Bordeaux AO is associated, not with an increase but with a decline of the average price difference, which dropped from around 21% to 8%.

These descriptive statistics thus suggest that there are strong effects in “Champagne Zone 1”, but much smaller effects for the other AOs. In the next section, we econometrically estimate the effects of AOs on wine prices.

4. Empirical Strategy

We exploit the progressive geographic implementation of AOs in a difference-in-differences (DID) framework, where departments not benefiting from AO serve to control for underlying trends in the outcome variables.¹⁷ The empirical model is as follow:

¹⁷ Gergaud, et al. (2015) also employ a difference-in-differences approach with endogenous treatments and analyze whether “*consumers’ quality perception and/or producer investment of New York City restaurants responds to newly appearing expert opinion*”.

$$P_{dt} = \alpha + \delta AO_{dt} + \gamma X_{dt} + \vartheta_d + \rho_t + \varepsilon_{dt}, \quad (1)$$

where P_{dt} is the average price of wine per hectoliter of department d in year t . The term AO_{dt} equals one if the AO was implemented in department d at time t , and 0 otherwise. It is equal to one in Aisne and Marne from 1908 onwards, and in Bordeaux, Aube, Haute-Marne and Seine-et-Marne from 1911 (Tables 1 and 2). The terms ϑ_d and ρ_t are fixed effects for department and year. The department fixed-effects account for regional permanent differences including, for example, fixed characteristics of the landscape and soil quality, while the year fixed-effects account for underlying trends in the outcome variables which could result from changes in consumer taste, in production process and regulations across France or in overall agricultural conditions. Our coefficient of interest is δ . It measures the impact of AO on wine prices in regions in which AO were implemented and all the production was under the AO. In other words, we measure the effects on those that were assigned to treatment (ATT) as opposed to the average treatment effect (ATE).¹⁸ The estimated impact on price of AO δ is unbiased if there are no department-level variations that are correlated with the implementation of AO and influence prices at the same time. In other words, our results are unbiased if during the year of implementation, no other factors impacting price varied in regions where the implementation occurred and did not vary in all other regions.

Three major events may violate this condition. The first is the *Phylloxera* crisis, which started in the south of France in 1863 and progressed to the north up until the end of the 1880s. We test the sensitivity of our results to the exclusion of the *Phylloxera* period. The other events

¹⁸ The distinction between ATE and ATT, and also between ATT and the average effects on nonparticipants (ATNT) is further detailed in Blundell and Costa-Dias (2009).

are World War I and the Great Depression which may have impacted the demand for specific wines differently, especially high quality wine such as Champagne Zone 1. We also test the sensitivity of our results to the exclusion of these time periods.

Our reading of historical documents at the time does not suggest that other events took place in some departments but not others. Even so, to verify the robustness of our results, we control for department-level confounding factors X_{dt} such as production and vine planted area. In some specifications, we also estimate a model allowing for a different impact of the AO on the different types of wines during our observation period. We therefore also implement the following model:

$$P_{dt} = \alpha + \delta_B AO_{dt}^B + \sum_{j=1}^2 \delta_j AO_{dt}^j + \gamma X_{dt} + \vartheta_d + \rho_t + \varepsilon_{dt} \quad (2)$$

where AO_{dt}^B is a dummy equal to one if the department is Bordeaux and the AO was implemented. AO_{dt}^1 and AO_{dt}^2 are dummies equal to one if the departments are in Champagne Zone 1 and 2 respectively, and the AOs were implemented. Therefore, δ_B captures the specific impact of AO on Bordeaux wines, and δ_1 and δ_2 capture the specific impact of AO on Champagne Zone 1 and 2 wines respectively. Our data set is at the department-level but the geographical area of AO wines could be smaller than the department. However, using historic records of AO planted area within each department we find that for both Champagne (Zone 1 and Zone 2) and Bordeaux, 100 percent of the land was producing AO wines at the time. Therefore, δ (and δ_B , δ_1 and δ_2) captures the ATT. All of our standard errors are clustered at the department level.

5. Results

5.1. Controls

Before proceeding to the results, we first check that the rollout of AO is orthogonal to changes in production characteristics. In theory, wine producers could change their production practise in order to benefit more substantially from the AO. For example, they could individually boost production in order to sell more wine at the new higher prices. In this case, our estimated impact would measure the net effect of a price increase due to the AO and a price decrease from the change in wine supply. Nonetheless, we test whether the impact we identify comes from the AO label and not from a decrease in production or planted area, which could also inflate wine prices. Figure 3 shows the trend over time for production, vine planted area, and yield. Yield is the ratio of production on planted area. The evolution is similar in the treated and control areas both prior to the rollout of AO and after. In Table 5, we formally check that the rollout is orthogonal using our baseline model (1) on the control variables. In specification 1, only the Appellation dummy the department and the year fixed effects are included, while specification 2 also includes the other control variable. Clearly, the rollout is not correlated with production and vine planted as none of the estimates are significant whether we include the controls or not. This suggests that production did not change after the AO were granted and that the impact we identify comes from the AO label.

Our identification strategy also relies on the assumption that control and treated areas share a common trend in the outcome variables. As previously seen, Figure 4.1 shows the trend over time for the average price per hectoliter. Prior to 1908 the price in both control and treated area

followed a similar pattern and eventually started to diverge as of 1908 when the first AO appeared in Champagne. During World War I (1914–18) and the Prohibition in the United States (1920–33) the price differences collapsed. We come back to these events when we discuss our results in further details. Together, these figures suggest that our empirical approach is well suited to isolate impact of AO on the price of wine when they were first introduced, but fails to control for demand shocks in total since high quality wines appear to be impacted more severely by demand shocks. This would bias our estimated impact downwards.

5.2. Main Results

Table 6 presents the ATT effects of AO on the average price of wines. In other words, it reports the average effect of AO on wine prices across all wines within departments assigned to the AO treatment group. In Table 6, all specifications include department and year fixed-effects, as well as controls for the total wine production in the department and the vine planted area. All specifications, except for specification 2, include all departments across France. Specification 2 only includes AO departments (before and after) and departments that share a border with AO departments (also before and after). In specifications 3 to 6, we test the sensitivity of our results to the exclusion of data observed during different major historical events potentially impacting the wine sector: the *Phylloxera* crisis (3), World War I (WWI) (4), the Great Depression (5), and all three events (6).

Using all of our observed data, we find an average impact of 28.7 francs per hl ($p=0.06$). While we have shown above that our control group appeared to be capturing well the overall trends in wine prices, in the second specification we further restrict the control group to departments

whose border touches departments in treated areas. We find an impact of 27.5 francs per hl, very much in line with our estimates using all departments. Restricting our attention to frontier departments does not change our results.

The AOs were implemented several years after a solution to the *Phylloxera* crisis was found (in 1890) and wine production had time to recover. Still, to see whether our results are affected by the *Phylloxera* outbreak we ran the regressions without the “*Phylloxera* years”. First, because the *Phylloxera* crisis impacted wine production, especially that of Bordeaux and surrounding areas before 1891, we exclude observations prior to 1891. This leads to a smaller impact of 23.8 francs per hl. Second, since departments were first hit by the crisis at different times and for different durations, we include a dummy variable equal to one when the *Phylloxera* crisis is ongoing in a department (Banerjee, et al. 2010; Gale, 2011; Paul, 1996 Tyman, 1879). Our main results remain very similar (Table 1, Appendix).

World War I (WWI) and the Great Depression had major impacts on the demand for wines around the world, especially Champagne wines which were considered a luxurious good even at the time. Excluding data during WWI (1914 to 1918)¹⁹ leads to a slightly larger impact (30.0 francs per hl), while the exclusion of data observed during the Great Depression (after 1928) leads to an even larger impact (36.0 francs per hl). These historical events impacted the wine sector, but taken together, when we exclude data from all three historical time periods, we find an overall impact of 34.2 francs per hl ($p=0.05$), slightly larger than the base result. The average price of AO wines prior to receiving the AO label was 45.9 francs per hl (Table 3) with a standard deviation of 24.5.

¹⁹ Note that if we exclude data from 1914 to 1924 to allow for post-war destruction and time required for vineyard reconstruction, our result becomes even stronger (36.2 francs per hl with a p-value of 0.062).

The estimated impact is thus equivalent to raising wine prices by 1.4 standard deviation. In other words, the AO label helped producers raise the price of wine by approximately 75% of the average price of wines prior to the introduction of AO labels. Even if we take the more conservative estimate shown in column 1 of Table 6, we still get a price increase of more than 60%. By any account, our results suggest that the AO label had a large impact on wine prices on average.

5.3. Heterogeneity per Type of Wine

Figures 5.3 and 5.4 suggest that the impact is not homogeneous across the different type of AO wines. In Table 7, we interact the type of wine with the Appellation dummy (see Equation (2)). We find that the increase in wine prices is almost entirely driven by Champagne wines (Zone 1) where the AO impact on these wines ranges between 60.9 francs per hl ($p=0.00$, specification 3) to 90.4 francs per hl ($p=0.00$, specification 5). Prior to the introduction of AOs, the price of Champagne Zone 1 wine was 60.8 francs per hl (Table 3) with a standard deviation of 30.7. The observed effects imply a rise of 100% to 149% on average. Wine producers clearly benefited from the AO. The impacts on Champagne wines (Zone 2) is also positive but not significant. While the impact is much more modest, between 7.46 to 11.70 francs per hl, it still represents a price increase of 23% to 33%. The impact on Bordeaux wines is generally negative and in some cases not significantly different from zero. It ranges between -7.58 to 0.48 francs per hl. Bordeaux wine producers did not benefit from the AO.

Table 8 presents further results on the heterogeneity of the effects from estimating the impact of AO on each type of wines separately. In doing so, we allow our control variables to have a different effect on the price of different wines and we better select our frontier control

departments. We find that our main conclusion remains. AO has a large positive impact on prices of Champagne Zone 1, but no impact on other types of wines.

As of 1927, Champagne Zone 1 and Champagne Zone 2 were regrouped into a single Appellation. Wine sold as of 1928 were thus impacted by this new regulation. To validate the impact of this change for each type of wine, we implement the following specification:

$$P_{dt} = \alpha + \delta_B AO_{dt}^B + \sum_{j=1}^2 (\delta_j AO_{dt}^j + \theta_j AO_{dt}^j I[t > 1927]) + \gamma X_{dt} + \vartheta_d + \rho_t + \varepsilon_{dt},$$

where θ_1 and θ_2 capture the impact of this new Appellation for Champagne Zone 1 and Zone 2 respectively.

The results in Table 9 indicate that while wines produced in Zone 2 did not see their prices increase significantly once under the same AO, prices of Zone 1 wines were negatively impacted. The negative effect for these wines ranges between 56.7 and 64.1 francs per hl. This period also coincides with the Great Depression. It is possible that the Great Depression had a larger negative impact on Champagne wines from Zone 1. We can therefore only conclude that within the context of the Great Depression, the new Appellation as of 1927 did not benefit Champagne wines.

5.4. Matching

In the present study, we are not worried about compositional changes between the treatment and control group. Departments cannot switch from the control to the treatment group or vice versa. However, to further ensure the comparability of the treatment and control groups over time and address the possibility of non-linearity of response with respect to X, we implement

the MDID estimator suggested by Heckman et al. (1997). With panel data, the MDID estimator is (Blundell and Costa-Dias, 2009):

$$\delta^{MDID} = \sum_{d \in T} \{ [P_{dt_1} - P_{dt_0}] - \sum_{j \in C} w_{dj} [P_{jt_1} - P_{jt_0}] \} \quad (3)$$

where department d can either be part of the treatment group T prior to (t_0) or after (t_1) the AO implementation, while department j can either be part of the control group C prior to (t_0) or after (t_1) year 1907. Each department j when compared to department d is attributed a specific weight w_{dj} that depends on the matching technique used. The MDID estimator controls for X semi-parametrically by ensuring that departments in the control group share the treatment group distribution for each of the characteristics contained in X . This estimator further ensures group comparability. Given the small number of control variables at our disposition, this approach is not entirely well-suited to assess the robustness of our results but nonetheless, it provides an additional check. Table 10 presents the MDID estimator using three different matching techniques: local linear regression matching, kernel matching and nearest neighbor matching with five neighbors. We also use three different set of control variables: (1) year dummies, (2) year dummies, and planted area and production in 1875 (our first year of observation), and (3) year dummies, and planted area and production in 1875 and 1907 (the last year before the first AO appeared). We find the overall impact of AO on wine prices is slightly larger when we use matching, but in line with our baseline estimate of 28.7 francs per hl. The local linear regression estimator suggests an effect of 29.5 to 30.5 francs per hl ($p=0.00$). Using different matching techniques leads to extremely similar results, 29.5 to 29.6 francs per hl ($p=0.00$) using kernel matching and 29.3 to 32.3 francs per hl ($p=0.00$) using nearest neighbor matching.

6. Discussion and Some Hypotheses

The strong heterogeneity of the effects obviously begs the question: why such different impacts? The most straightforward hypothesis is related to the quality variation of the wine within the AO. Experts and writers point out that the average quality of the wines in the Champagne AO, especially in Zone 1, was relatively high compared to the average quality of Bordeaux AO wines. While the Bordeaux AO was limited to the Gironde department (despite lobbying to include also two other departments), the Bordeaux AO area was still very large with 140,000 hectares, and it include heterogeneous wines. The Bordeaux AO area included both wines from the traditional Sauternes region (southeast of the city of Bordeaux along the Garonne river) producing “high quality” wines or from the Palus region (in the former seaside marshes south of Bordeaux bordering the Garonne river). Experts judged wines from the first region as “high quality” and clearly superior to the “low quality” wines of the second region (Leroy, 1931). In fact, later on, additional production criteria were introduced (e.g., in 1935) to better control the wines produced in the Bordeaux AO.²⁰

The higher average quality of Champagne versus Bordeaux AO wines may also be reflected in the fact that almost 70% of the Champagne wines were exported whereas only 18% of Bordeaux wines were exported (see Table 2 and Figure 6).²¹

²⁰ Livat, Alston and Cardebat (2018) suggest that the current AOs in the Bordeaux wine area are too numerous and complex to provide helpful quality signals to consumers. This result opens a general discussion about the optimal number of AOs in the wine sector.

²¹ In 1913, Champagne wine was exported to Belgium (57,000 hectoliters), England (54,000 hectoliters), the United States (12,800 hectoliters), Argentina (8,162 hectoliters), Russia (8,160 hectoliters) and Germany (8,100 hectoliters). From 1900–1909, Champagne wine exports doubled in Russia, tripled in Belgium, quadrupled in the United States and increased tenfold in Argentina. On the other hand, the demand for champagne in the English market dropped by one-third (Bonal, 1984; see Figure 6).

The difference between Zone 1 and Zone 2 in the Champagne AO is also consistent with articles and books identifying the Zone 1 region with “only high-quality” wines and the Zone 2 region with a mixture of higher and lower quality wines. Whether this was actually the case or whether this was mostly perceptions is difficult to show. What is clear though is that, if one uses price as a quality indicator that Zone 1 Champagne sold at much higher prices than Zone 2 Champagne—and the integration of both zones into a single “Champagne AO” was associated with a decline in the price premium paid for wines from Zone 1.

7. Conclusion

Our study used historical data from 1875 to 1935 to analyse how regulations that formally established a link between product quality and production location (*terroir*) affected the price of wines in France. We find that the introduction of geographical indications or “Appellations of Origin” (*Appellations d’Origine*–AO) in the early twentieth century significantly increased the price of specific wines in the Champagne AO, but not in the Bordeaux AO in the years and decades following their introduction. Moreover, there are significant differences in the price effect within the Champagne region: wines from Zone 1 (Marne and Aisne departments) increased strongly but wines from Zone 2 saw much less of an impact. After the merger of both regions, the average effect declined.

We hypothesize that the AO effect is related with the average quality and the heterogeneity of the quality inside the AO. With consistent and high quality of wines inside the AO, the regulation of *terroir* through the introduction of AOs (or GIs) more generally, can create significant price premiums. However, if that is not the case, the value of *terroir* may be limited.

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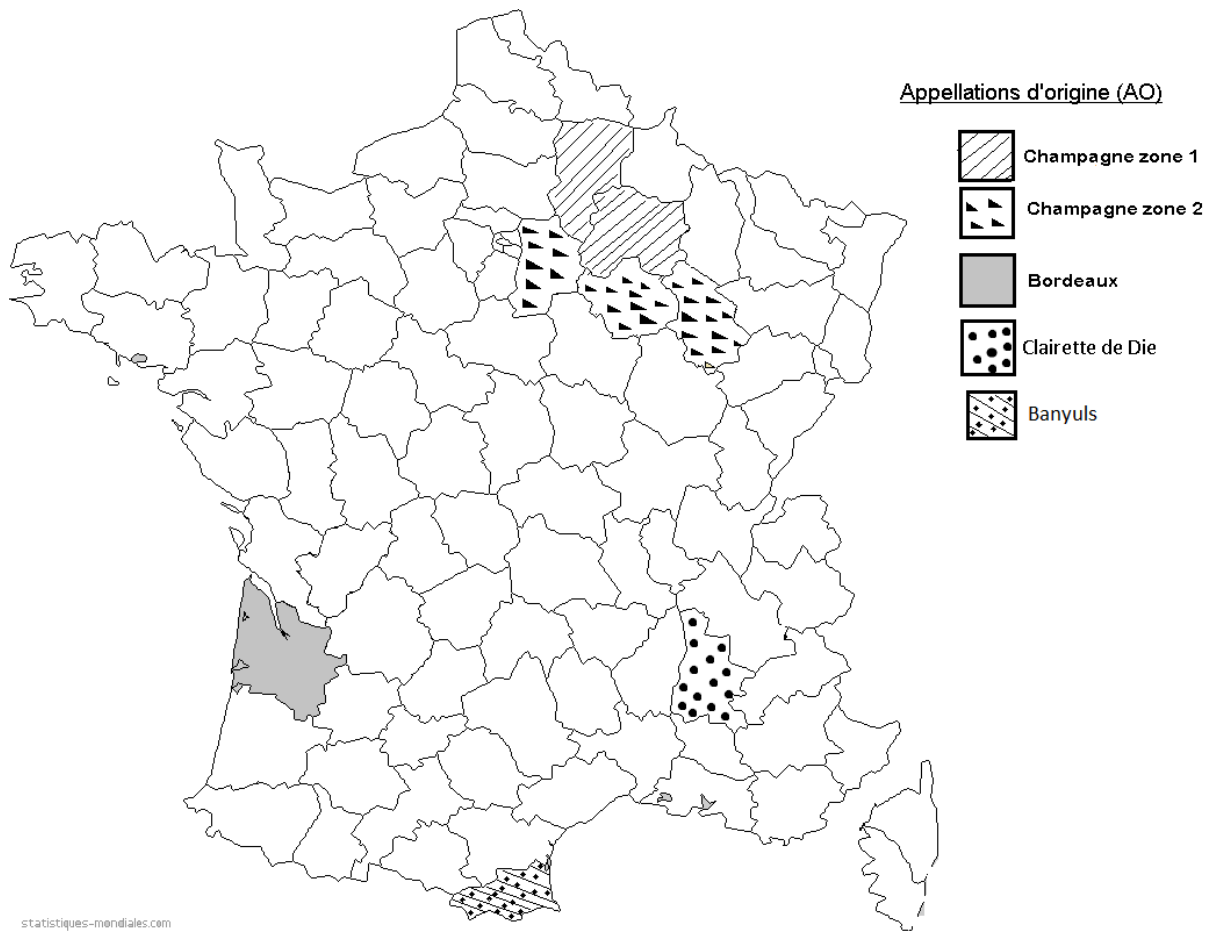
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Figures

Figure 1

Appellations' Location in France



Note: This figure shows the geographical position of the various areas that obtained an Appellation during our observation period. The Figure only captures the departments' location and not the actual planted vine area. "Champagne Zone 1" corresponds to the Marne and Aisne departments; "Champagne Zone 2" corresponds to the Aube, Haute-Marne and Seine-et-Marne departments; Bordeaux to the Gironde department; Clairette de Die to the Drôme department; and Banyuls to the Pyrénées-Orientales department (see Table 2).

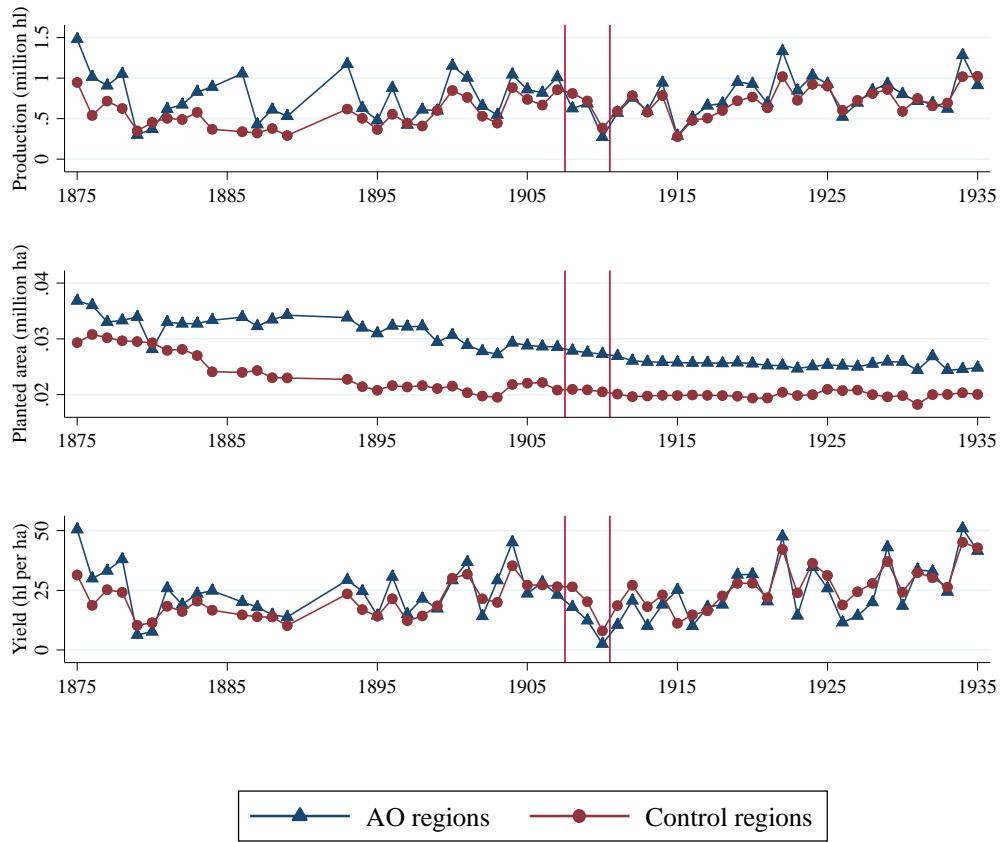
Figure 2

Extract from the *Annuaire Statistique de la France*, 1905, p. 148

NUMÉROS D'ORDRE.	DÉPARTEMENTS.	VIGNES PRODUCTIVES.				
		Superficie cultivée.	Production totale.	Production moyenne par hectare.	Valeur totale.	Valeur moyenne de l'hectolitre.
		hectares.	hectolitres.	hectolitres.	francs.	fr. c.
1	AIN.....	16,863	562,255	33.34	14,056,375	25 00
2	AISNE.....	1,021	103,000	53.61	3,090,000	30 00
3	AULLIER.....	15,355	477,847	31.12	14,655,567	30 67
4	ALPES (BASSES-)... ..	6,176	77,200	12.50	2,702,000	35 00
5	ALPES (HAUTES-)... ..	2,207	45,029	19.60	900,580	20 00
6	ALPES-MARITIMES.....	10,250	61,400	5.09	1,842,000	30 00
7	ARDÈCHE.....	17,914	501,592	28 00	9,279,452	18 50
8	ARDENNES.....	243	8,516	35.04	583,220	45 00
9	ARIÈGE.....	6,545	164,925	25.19	3,298,500	20 00
10	AUBE.....	8,063	241,800	30.00	6,289,140	26 00
11	AUDE.....	131,379	7,895,000	60.09	39,475,000	5 00
12	AVEYRON.....	13,869	615,090	44.35	13,150,624	21 38
13	BOUCHES-DU-RHÔNE.....	29,877	1,144,289	38.30	16,020,046	14 00

Figure 3

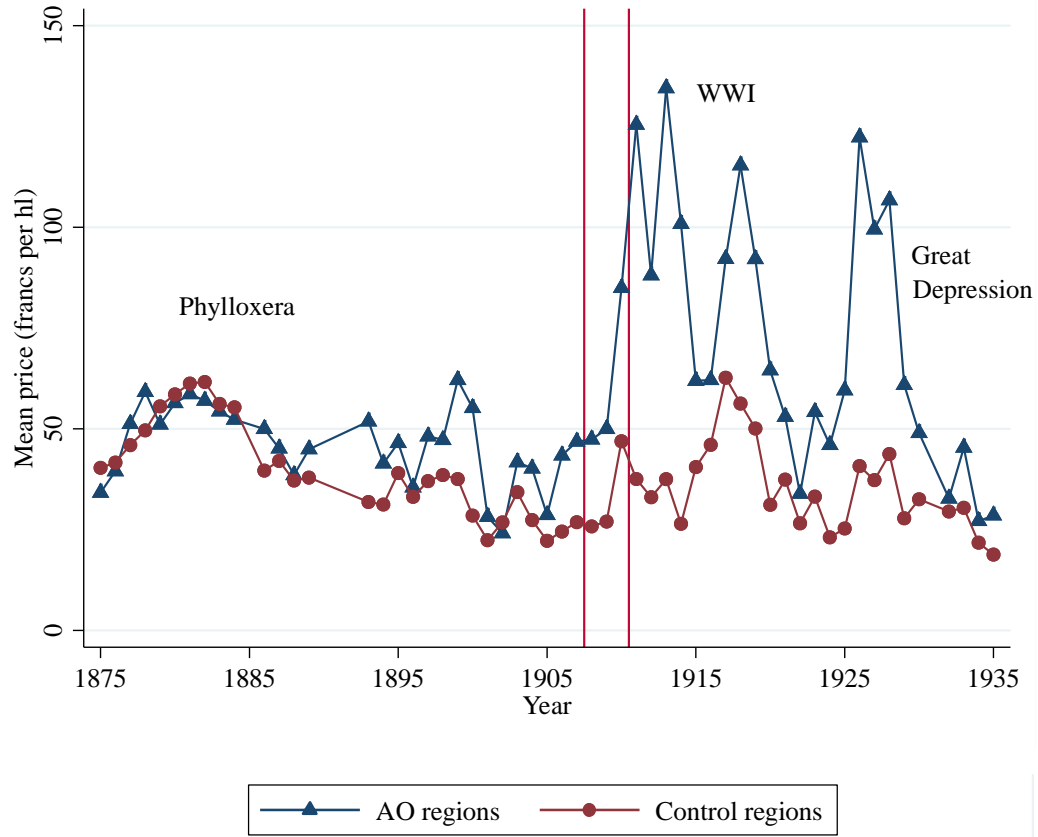
Characteristics over Time of AO and Control Regions



Note: This figure shows the mean value of our control variables in treated (marked by a triangle) and control (marked by a circle) areas over time. The two vertical lines mark the beginning and the end of the implementation of appellations across France during our observation period.

Figure 4.1

Average Price Deflated Over Time in Appellations Area (Treated) and Control Areas in Francs per Hectoliter



Note: This figure shows the average price per hectoliter of wine in treated and control areas over time. The two vertical lines mark the beginning and the end of the implementation of appellations across France during our observation period.

Figure 4.2

Ratio of Appellations and Control Areas Average Prices

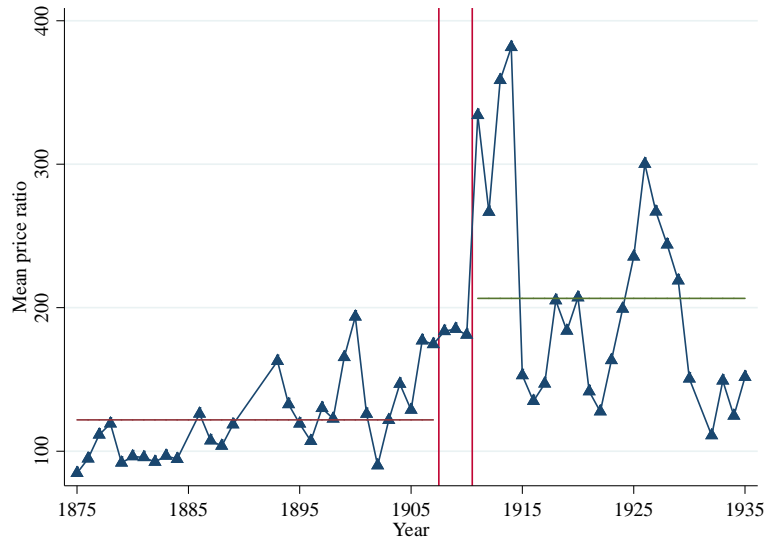


Figure 4.3

**Ratio of Appellations and Control Areas Average Prices,
with as Control only the Frontier Departments**

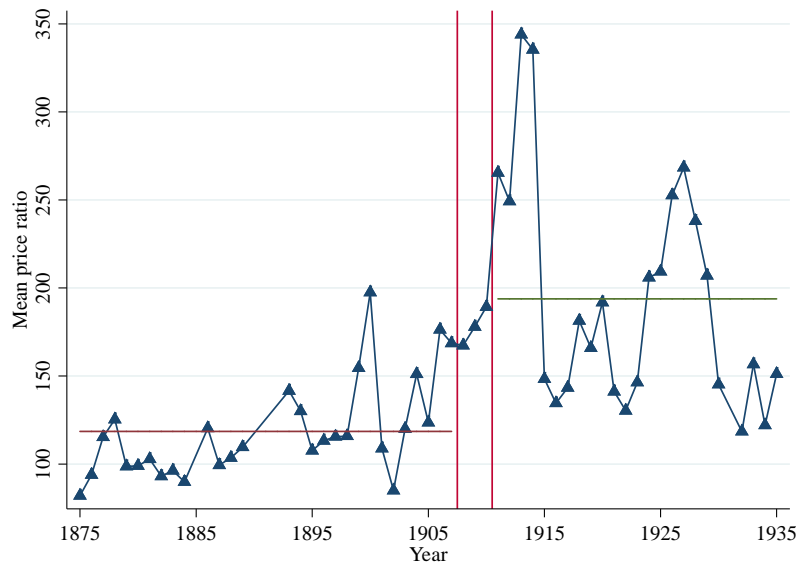


Figure 5.1

Average Price Deflated Over Time in Appellations Area (Treated) and Control Areas, in Francs per Hectoliter

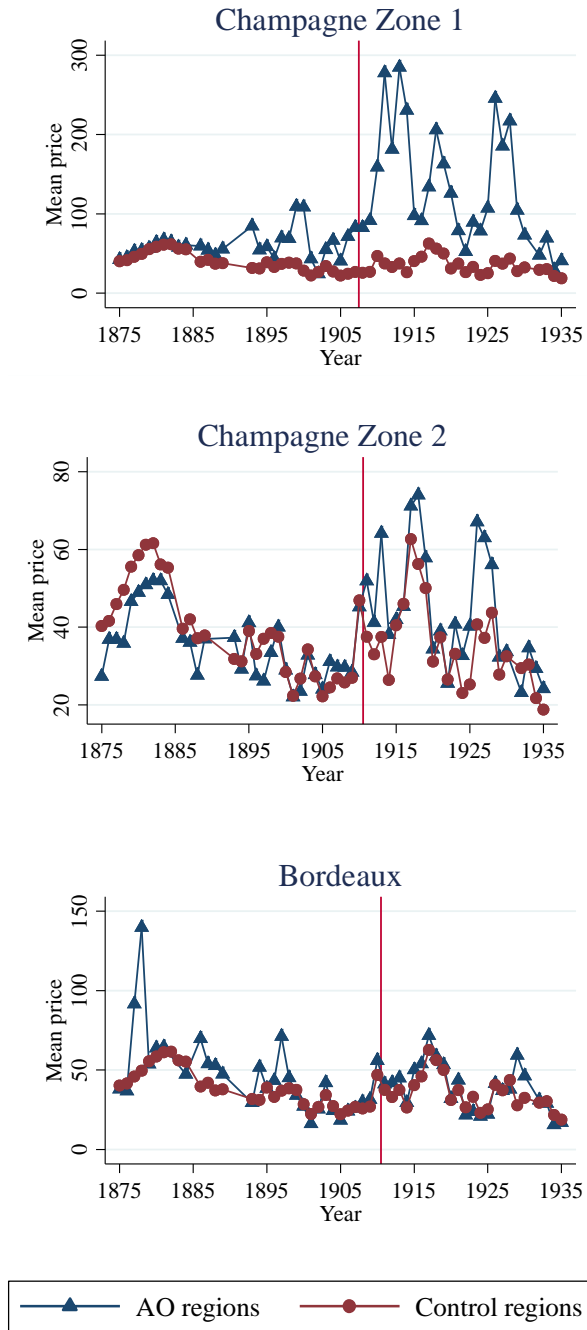


Figure 5.2

Average Price Deflated Over Time in Appellations Area (Treated) and Frontier Departments, in Francs per Hectoliter

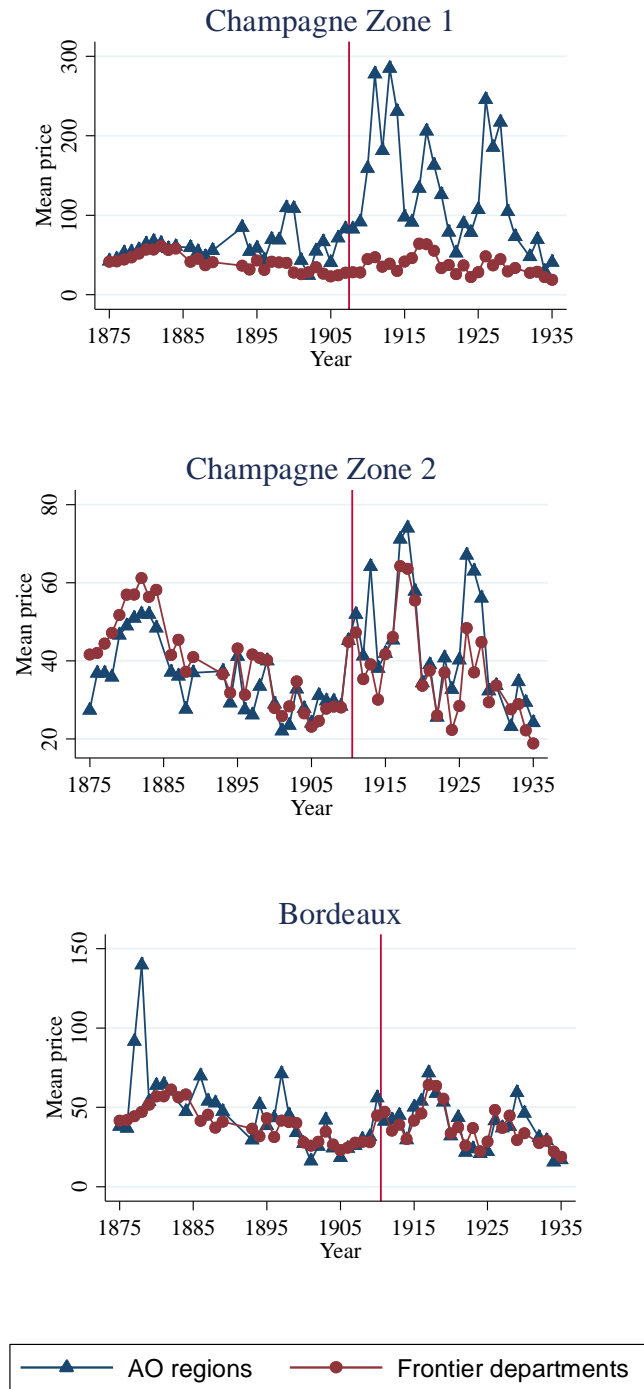
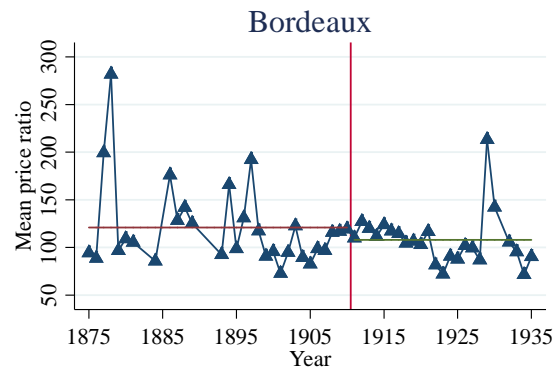
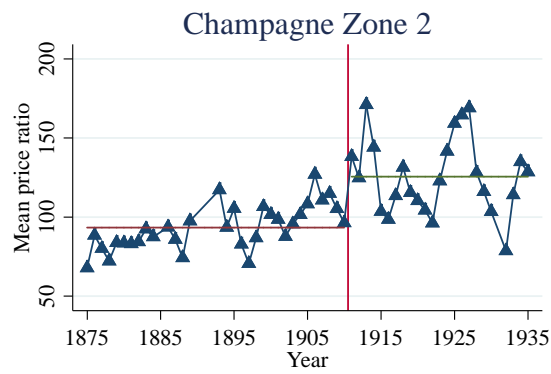
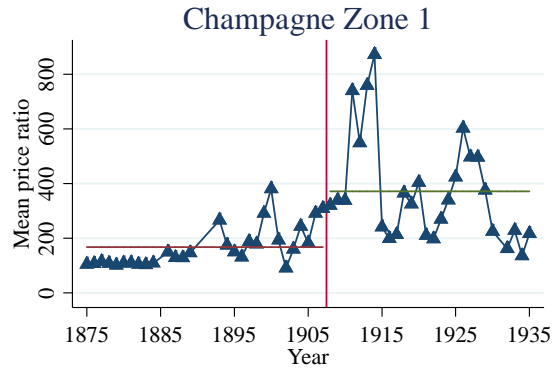


Figure 5.3

Ratio of Appellations and Control Areas Average Prices

a) By Appellations



b) By Appellations, combined

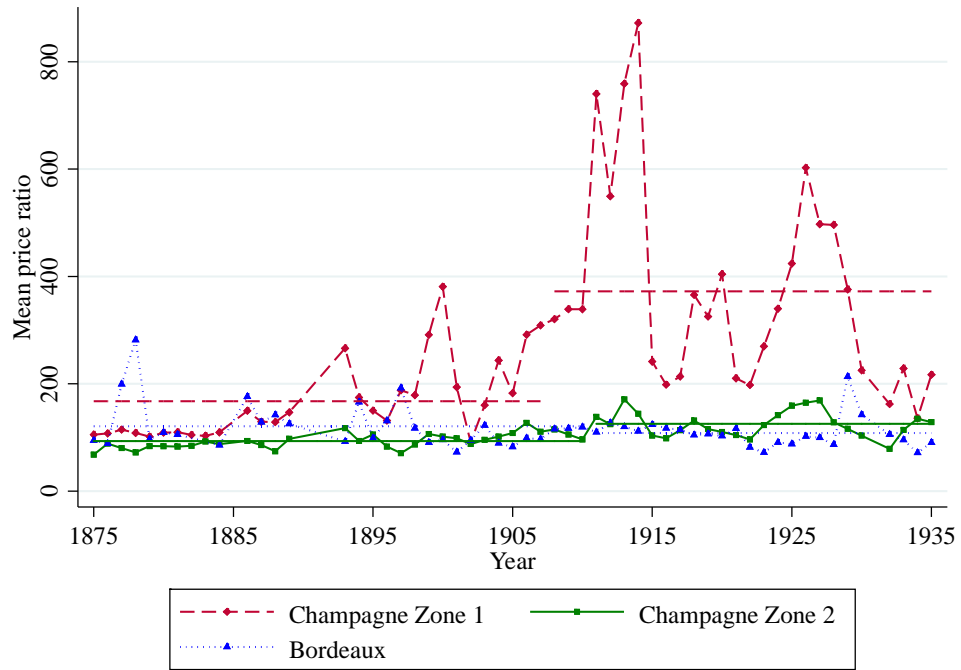
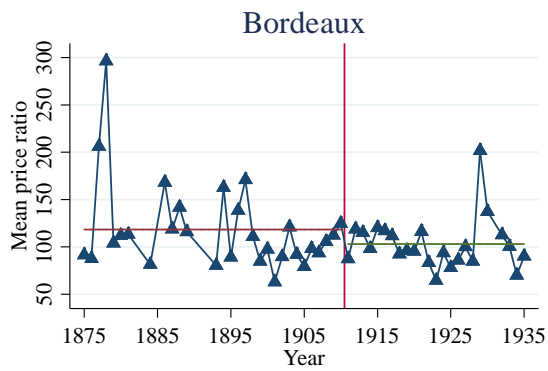
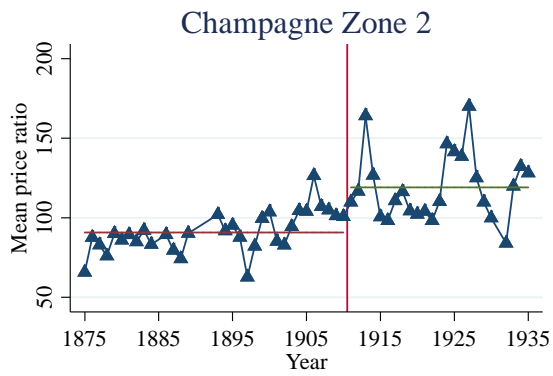
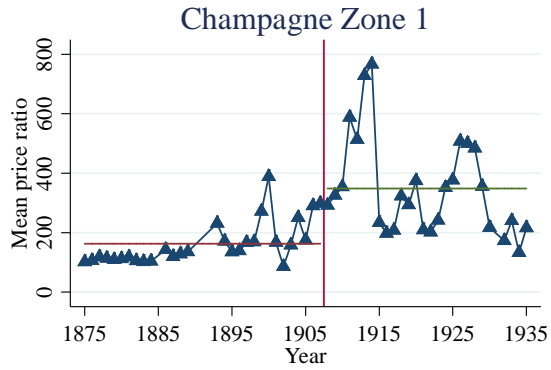


Figure 5.4

Ratio of Appellations and Control Areas (only Frontier Departments) Average Prices

a) By Appellations



b) By Appellations, combined

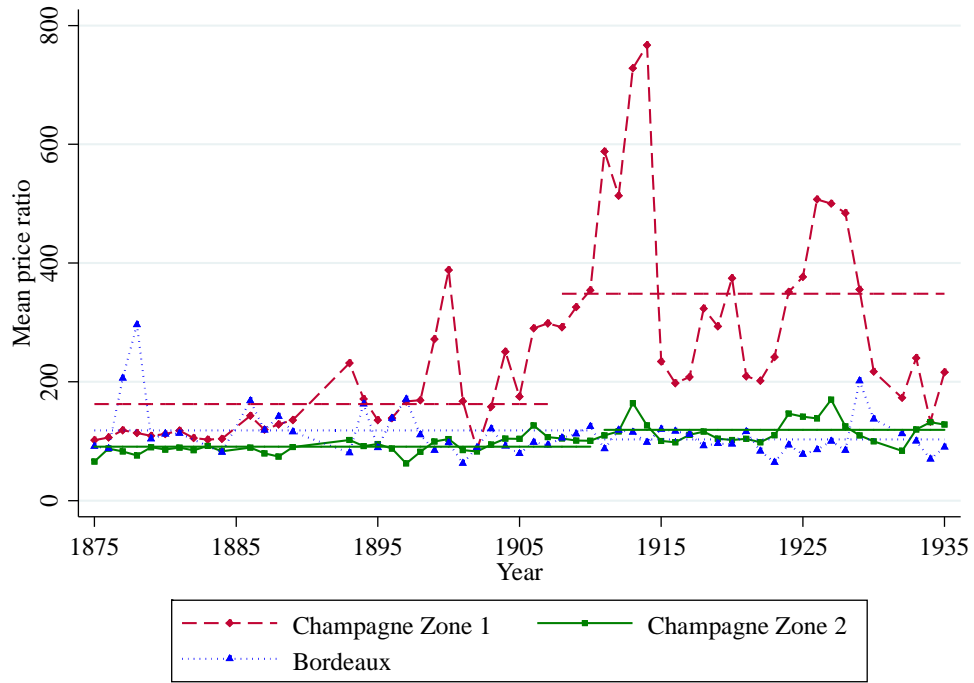
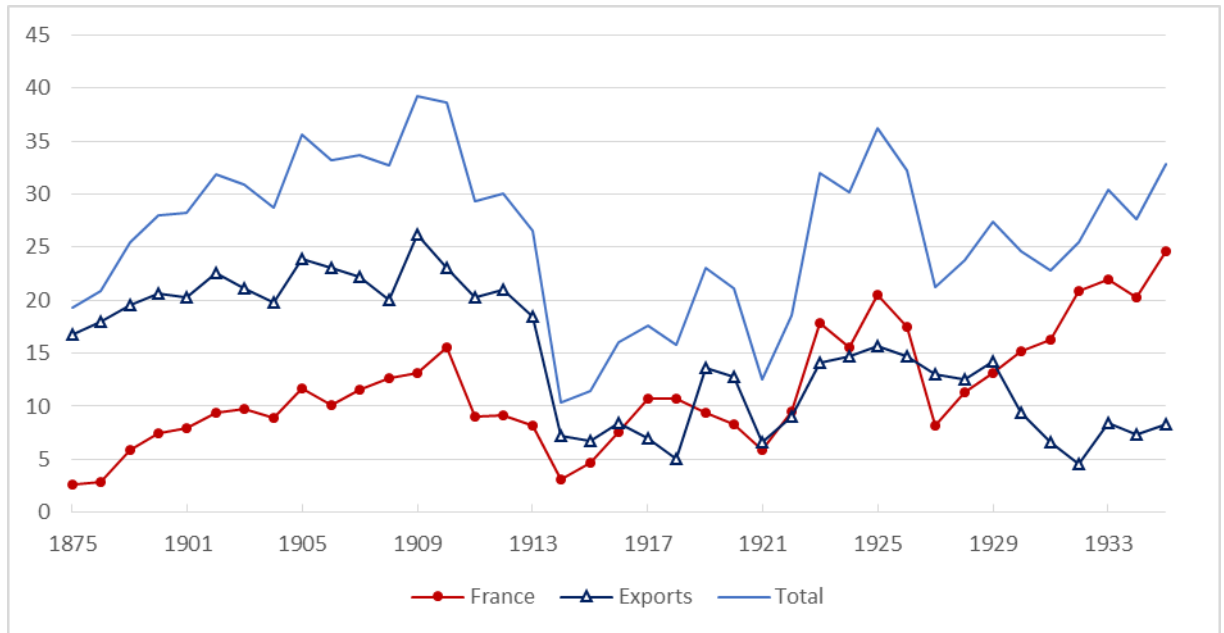


Figure 6

Domestic Sales and Exports of Champagne Wine in million bottles, 1875–1935



Note: Before 1908, Champagne and sparkling wines of the Marne don't have to justify the "origin".

Sources: for 1875–1900 see Simpson (2011, p. 136); for 1900–1935 see Bonal (1984) and Comité Interprofessionnel du Vin de Champagne (CIVC 2015) data.

Tables

Table 1

Chronology of Appellations of Origin Wines in France, 1908-1911

Bordeaux	1911: first AO delimitation (Decree of February 18, 1911)
Champagne	1908: first AO delimitation (Decree of December 17, 1908) 1911: creation of a “Champagne Zone 2” (Decree of June 7, 1911)
Clairette de Die	1910: first AO delimitation (Decree of April 21, 1910)
Banyuls	1909: Banyuls (Languedoc-Roussillon) first AO delimitation (Decree of September, 18 1909)

Sources: JORF, 1909a, 1909b, 1910, 1911a, 1911b, 1911c.

Table 2

Appellations of Origin and Departments' Characteristics

<i>Appellations</i>	<i>Departments</i>	<i>Total area planted (in hectares) at the time of the introduction of the AO</i>	<i>% of department's area planted under AO at the time of the introduction of the AO</i>	<i>% of exports (1900–09)</i>
Champagne Zone 1 (1908)	Aisne;	1,766	100%	68%
	Marne	13,870	100%	
Champagne Zone 2 (1911)	Aube;	5,688	100%	
	Haute-Marne;	3,618	100%	
	Seine-et-Marne	1,260	100%	
Bordeaux	Gironde	136,081	100%	18%
Clairette de Die	Drôme	16,814	9%	-
Banyuls	Pyrénées-Orientales	61,419	3%	-

Sources: JORF, 1909a, 1909b, 1910, 1911a, 1911b, 1911c. For exports figures see Simpson (2011, pp. 128 and 136).

Table 3
Summary Statistics

	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
AO Departments	Period: <1908			Period: >=1908		
Price per hl	172	45.855	24.505	162	71.769	69.172
Production	174	0.781	1.297	168	0.761	1.623
Area planted	174	0.032	0.048	168	0.026	0.049
Control Departments	Period: <1908			Period: >=1908		
Price per hl	2,124	39.878	18.499	1,848	35.115	14.673
Production	2,052	0.556	1.119	1,919	0.712	1.672
Area planted	2,058	0.024	0.03	1,924	0.02	0.029
Champagne Zone 1	Period: <1908			Period: >=1908		
Price per hl	58	60.784	30.674	83	112.007	80.668
Production	58	0.252	0.232	85	0.233	0.222
Area planted	58	0.009	0.006	85	0.009	0.006
Champagne Zone 2	Period: <1911			Period: >=1911		
Price per hl	96	35.357	10.242	72	44.238	22.725
Production	96	0.25	0.241	75	0.045	0.049
Area planted	96	0.011	0.006	75	0.002	0.002
Bordeaux	Period: <1911			Period: >=1911		
Price per hl	30	46.484	24.855	24	38.538	14.798
Production	32	3.321	1.315	25	4.328	1.268
Area planted	32	0.137	0.008	25	0.135	0.003

Table 4

Average Price Ratio

	Before the introduction of the AO (in %)	After the introduction of the AO (in %)
All appellations	21.8	106.5
Bordeaux	20.8	8.1
Champagne Zone 1	67.6	272.2
Champagne Zone 2	-6.7	25.5

Table 5

Orthogonality of the Rollout to Production Characteristics

VARIABLES	Production		Vine area planted	
	(1)	(2)	(3)	(4)
Appellation	-0.113 (0.576)	-0.085 (0.622)	-0.001 (0.605)	0.000 (0.982)
Area planted		29.609*** (0.001)		
Production				0.009*** (0.000)
Constant	0.998*** (0.000)	0.100 (0.753)	0.030*** (0.000)	0.022*** (0.000)
Observations	4,313	4,307	4,324	4,307
Year FE	yes	yes	yes	yes
Department FE	yes	yes	yes	yes
R-squared	0.096	0.332	0.105	0.339

Note: Each column presents a separate regression. The dependent variables are production in millions of hectoliters (columns 1 and 2) and vine planted area in millions of hectares (columns 3 and 4). Appellation is a dummy variable equal to one if the department is in Bordeaux, Champagne Zone 1 or 2, and the AO is implemented. All regressions include year and department fixed effects. P-values corrected for clustering and autocorrelation by clustering at the department level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6

Estimated Impact of AO on Wine Prices (ATT)

	All observations	AO & Frontier Departments	Excluding <i>Phylloxera</i> (<1891)	Excluding WWI (1914–18)	Excluding Great Depression (>1928)	Excluding all three periods
	(1)	(2)	(3)	(4)	(5)	(6)
Appellation	28.659* (0.060)	27.510* (0.088)	23.754** (0.041)	29.992* (0.061)	36.032* (0.062)	34.160** (0.050)
Production	-1.426 (0.210)	-7.607*** (0.008)	-2.374* (0.073)	-1.369 (0.255)	-1.696 (0.184)	-2.806 (0.110)
Area planted	-57.717* (0.090)	4.778 (0.961)	-46.114 (0.525)	-57.678* (0.100)	-55.540 (0.113)	-71.090 (0.359)
Constant	37.768*** (0.000)	47.388*** (0.000)	36.156*** (0.000)	37.726*** (0.000)	37.953*** (0.000)	37.005*** (0.000)
Observations	4,201	1,035	3,153	3,907	3,752	2,410
Year FE	yes	yes	yes	yes	yes	yes
Department FE	yes	yes	yes	yes	yes	yes
R-squared	0.400	0.325	0.387	0.357	0.404	0.320

Note: Each column presents a separate regression. The dependent variable is price in francs per hectoliter. Appellation is a dummy variable equal to one if the department is in Bordeaux, Champagne Zone 1 or 2, and the AO is implemented. All regressions include year and department fixed effects. A total of 84 departments are observed. The subsample of frontier departments includes 20 departments. P-values corrected for clustering and autocorrelation by clustering at the department level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7

Region Specific Impacts of AO on Wine Prices (ATT)

	All observations	AO & Frontier Departments	Excluding <i>Phylloxera</i> (<1891)	Excluding WWI (1914–18)	Excluding Great Depression (>1928)	Excluding all three periods
	(1)	(2)	(3)	(4)	(5)	(6)
Bordeaux (δ_B)	-6.384*** (0.000)	-3.812 (0.167)	0.475 (0.672)	-7.164*** (0.000)	-7.577*** (0.000)	-1.919 (0.207)
Champagne Zone 1 (δ_1)	72.828*** (0.000)	71.239*** (0.002)	60.911*** (0.000)	75.527*** (0.000)	90.448*** (0.000)	86.178*** (0.000)
Champagne Zone 2 (δ_2)	9.948 (0.105)	7.456 (0.279)	8.148 (0.200)	10.358 (0.127)	11.736 (0.127)	10.735 (0.245)
Constant	37.932*** (0.000)	46.501*** (0.000)	36.621*** (0.000)	37.858*** (0.000)	38.140*** (0.000)	37.678*** (0.000)
Observations	4,201	1,035	3,153	3,907	3,752	2,410
Year FE	yes	yes	yes	yes	yes	yes
Department FE	yes	yes	yes	yes	yes	yes
Production & Area	yes	yes	yes	yes	yes	yes
R-squared	0.465	0.432	0.428	0.427	0.498	0.416

Note: Each column presents a separate regression. The dependent variable is price per hectoliter. Bordeaux is a dummy equal to one if the department is Bordeaux and the AO was implemented. Champagne Zone 1 is a dummy equal to one if the department is in Zone 1 and the AO was implemented. Champagne Zone 2 is a dummy equal to one if the department is in Zone 2 and the AO was implemented. All regressions include year and department fixed effects. A total of 84 departments are observed. The subsample of frontier departments includes 20 departments. P-values corrected for clustering and autocorrelation by clustering at the department level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8

Estimated Impact of AO on Champagne and Bordeaux

	Champagne zone 1 (1)	Champagne zone 2 (2)	Bordeaux (3)
Appellation	74.803*** (0.008)	3.621 (0.645)	-3.302 (0.143)
Production (mln hl)	-119.079*** (0.001)	-9.408* (0.086)	-1.003 (0.490)
Area planted (mln ha)	-54.309 (0.966)	-258.957 (0.326)	-142.290 (0.147)
Constant	89.444*** (0.000)	48.287*** (0.000)	42.947*** (0.006)
Observations	254	504	333
Year FE	yes	yes	yes
Department FE	yes	yes	yes
Planted area & production	yes	yes	yes
R-squared	0.602	0.559	0.745

Note: Each column presents a separate regression for each of the treated regions. Column 1 includes observations from Champagne Zone 1 and frontier departments. Column 2 includes observations from Champagne Zone 2 and frontier departments. Column 3 includes observations from Bordeaux and frontier departments. The dependent variable is price per hectoliter. Appellation is a dummy variable equal to one if the department is in Bordeaux, Champagne Zone 1 or 2, and the AO is implemented. All regressions include year and department fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Table 9

Region Specific Impacts of AO on Wine Prices (ATT), before and after 1927

	All observations (1)	Excluding Phylloxera and WWI (2)
Bordeaux (δ_B)	-6.479*** (0.000)	-0.289 (0.834)
Champagne Zone 1 (δ_1)	87.508*** (0.001)	83.045*** (0.000)
Champagne Zone 2 (δ_2)	11.711 (0.108)	10.932 (0.217)
Champagne Zone 1 >1927 (θ_1)	-56.720** (0.011)	-64.080** (0.010)
Champagne Zone 2 >1927 (θ_2)	-6.436 (0.112)	-7.505 (0.166)
Constant	37.939*** (0.000)	36.530*** (0.000)
Observations	4,201	2,859
Year FE	yes	yes
Department FE	yes	yes
Production & Area planted	yes	yes
R-squared	0.489	0.397

Note: Each column presents a separate regression. The dependent variable is price per hectoliter. Column 1 includes all observations. Column 2 excludes observation during the *Phylloxera* crisis and WWI. Bordeaux is a dummy equal to one if the department is Bordeaux and the AO was implemented. Champagne Zone 1 is a dummy equal to one if the department is in Zone 1 and the AO was implemented. Champagne Zone 2 is a dummy equal to one if the department is in Zone 2 and the AO was implemented. Champagne Zone 1 >1927 is a dummy equal to one if the department is in Zone 1 after 1927. Champagne Zone 2 >1927 is a dummy equal to one if the department is in Zone 2 after 1927. All regressions include year and department fixed effects. A total of 84 departments are observed. The subsample of frontier departments includes 20 departments. P-values corrected for clustering and autocorrelation by clustering at the department level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10

Matching Difference-in-Differences Estimator of AO on Wine Prices

	(1)			(2)			(3)		
	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t	Coef.	Std. Err.	P>t
Local linear regression									
AO MDID	30.48	5.6	0	29.44	5.58	0	29.5	5.58	0
treated	8.54	3.82	0.03	8.77	3.81	0.02	8.98	3.81	0.02
post	-1.01	3.95	0.8	0.04	3.93	0.99	-0.02	3.94	1
constant	36.64	2.75	0	36.42	2.74	0	36.21	2.74	0
Kernel									
AO MDID	29.54	5.58	0	29.46	5.58	0	29.64	5.58	0
treated	3.81	2.41	1.71	8.37	3.81	0.03	8.53	3.81	0.03
post	-0.06	3.94	0.99	0.01	3.93	1	-0.16	3.94	0.97
constant	35.99	2.74	0	36.82	2.74	0	36.66	2.74	0
Nearest neighbor (5)									
AO MDID	32.28	5.63	0	29.74	5.62	0	29.31	5.63	0
treated	7.02	3.85	0.07	9.08	3.84	0.02	11.94	3.85	0
post	-2.81	3.97	0.48	-0.26	3.96	0.95	0.17	3.97	0.97
constant	38.16	2.77	0	36.11	2.76	0	33.25	2.76	0
Matching									
Year dummies	yes			yes			yes		
Planted area & production									
Current year	yes			yes			yes		
Year 1875	no			yes			yes		
Year 1907	no			no			yes		

Note: Each set of three columns and each panel presents a separate regression. The dependent variable is price per hectoliter. Three matching techniques are used: local linear regression (panel 1) and kernel (panel 2), both with a bandwidth equal to 0.06, and nearest neighbor with five neighbors (panel 3).

Appendix

Table 1

Estimated Impact of AO on Wine Prices (ATT)

	All observations	AO & Frontier Departments	Excluding WWI (1914–18)	Excluding Great Depression (>1928)
	(1)	(2)	(3)	(4)
Appellation	28.635* (0.060)	26.361* (0.095)	29.955* (0.061)	35.989* (0.062)
Production (mln hl)	-1.394 (0.192)	-6.515** (0.013)	-1.316 (0.244)	-1.636 (0.172)
Area planted (mln ha)	-58.947* (0.065)	-69.636 (0.412)	-59.691* (0.067)	-57.789* (0.078)
Phylloxera	0.372 (0.864)	9.708 (0.170)	0.567 (0.788)	0.677 (0.762)
Constant	37.701*** (0.000)	46.824*** (0.000)	37.623*** (0.000)	37.830*** (0.000)
Observations	4,201	1,035	3,907	3,752
Year FE	yes	yes	yes	yes
Department FE	yes	yes	yes	yes
R-squared	0.400	0.330	0.357	0.404

Note: Each column presents a separate regression. The dependent variable is price per hectoliter. Appellation is a dummy variable equal to one if the department is in Bordeaux, Champagne Zone 1 or 2, and the AO is implemented. *Phylloxera* is a dummy equal to one if the *Phylloxera* crisis is ongoing in the department. All regressions include year and department fixed effects. A total of 84 departments are observed. The subsample of frontier departments includes 20 departments. P-values corrected for clustering and autocorrelation by clustering at the department level in parentheses. *** p<0.01, ** p<0.05, * p<0.1