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ABSTRACT

Long Run Impacts of Income Shocks: Wine and Phylloxera in 19th Century France*

This paper provides estimates of the long-term effects on height and health of a large income shock experienced in early childhood. Phylloxera, an insect that attacks the roots of grape vines, destroyed 40% of French vineyards between 1863 and 1890, causing major income losses among wine growing families. Because the insects spread slowly from the southern coast of France to the rest of the country, Phylloxera affected different regions in different years. We exploit the regional variation in the timing of this shock to identify its effects. We examine the effects on the adult height, health, and life expectancy of children born in the years and regions affected by the Phylloxera. The shock decreased long run height, but it did not affect other dimensions of health, including life expectancy. We find that, at age 20, those born in affected regions were about 1.8 millimetres shorter than others. This estimate implies that children of wine-growing families born when the vines were affected in their regions were 0.6 to 0.9 centimetres shorter than others by age 20. This is a significant effect since average heights grew by only 2 centimetres in the entire 19th century. However, we find no other effect on health, including infant mortality, life expectancy, and morbidity by age 20.

JEL Classification: I12, N32 and O12
Keywords: fetal origin, height and military data

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1. Introduction

Poor environmental conditions in-utero and early childhood have been shown to have adverse consequences on later life outcomes, including life expectancy, height, cognitive ability, and productivity (Barker, 1992)[6]. Important influences include the disease environment (Almond, 2006), the public health infrastructure (Almond and Chay, 2005), food availability (see e.g. Almond et al. (2006) and Qian (2006) on the great Chinese famine, Rosebloom et al. (2001) and Ravelli et al (2001) on the Dutch famine of 1944-1945), and even the availability of certain seasonal nutrients (Doblhammer, 2000).

At the same time, evidence from developing countries suggests that young children's nutritional status, not surprisingly, is affected by family income (see e.g. Jensen, 2000, Duflo, 2003). Taken together, these two facts suggest that, at least in poor countries, economic crises may have important long term impacts on the welfare of the cohorts born during these periods.[7] Yet, except for the few papers on famines mentioned above, there is very little evidence establishing a direct link between economic events at birth and adult outcomes. This is perhaps not surprising, since such an analysis requires good data on adult outcomes, coupled with information on economic conditions faced during early childhood. Longitudinal data is often not available over such long time periods, especially in poor countries, except for dramatic events such as famines. As a result, the few existing studies tend to be limited to cohort analyses: For example, Van Den Berg, Lindeboom and Portrait (2006) show that, among cohorts born between 1812 and 1912 in the Netherlands, those born in slumps have lower life expectancy than those born in booms. However, a concern with using just time variation is that it might reflect other

[6] The idea that in-utero conditions affect long run health is most commonly associated and referred to as the "fetal origin hypothesis", and associated to DJP Barker (see e.g. Barker, 1992, 1994). For additional evidence see, among others, Strauss and Thomas (1995), Case and Paxson (2006), Berhman and Rozenzweig (2005) and references therein.

[7] In rich countries this effect may be compensated by the fact that pollutants diminish during economic slumps (Chay and Greenstone, 2003).

time-specific elements, such as the quality of public services, the relative price of different nutrients, or even conditions in adulthood. To fill this gap, this paper takes advantage of the Phylloxera crisis in 19th century France, which, we will argue, generated a negative large income shock that affected different "departments" (roughly similar in size to a US county) in France in different years, combined with the rich data on height and health that was collected by the French Military Administration.

Phylloxera (an insect that attacks the roots of vines) destroyed a significant portion of French vineyards in the second half of the 19th century. Between 1863, when it first appeared in Southern France, and 1890, when vineyards were replanted with hybrid vines (French stems were grafted onto Phylloxera-resistant American roots), Phylloxera destroyed 40 percent of the French vineyards. Just before the crisis, about one sixth of the French agricultural income came from wine, mainly produced in a number of small highly specialized wine-growing regions. For the inhabitants of these regions, the Phylloxera crisis represented a major income shock. Because the insects spread slowly from the southern coast of France to the rest of the country, Phylloxera affected different regions in different years. We exploit this regional variation in the timing of the shock to identify its effects, using a difference-in-differences strategy.

We examine the effect of this shock on the adult height, health, and life expectancy outcomes of children born in years where the Phylloxera affected their region of birth, controlling for region and year of birth effects. The height and health data comes from the military: Every year, all the conscripts (who were a little over 20 at the time of reporting) were measured and the number of young men falling into a number of height categories was reported at the level of the department. The statistics also reported the number of young men who had to be exempted for health reasons, and specified the grounds of exemption. This data is available for 83 departments which are consistently defined over the period we consider.[8] In addition, we use data on female life expectancy at birth constructed from the censuses and reports of vital statistics.

In many ways, France in the late 19th century was a developing country: In 1876 the female life expectancy was 43 years; infant mortality was 22 percent; and the average male height at the age of 20 was 1.65 meters, approximately the third percentile of the American population today. The Phylloxera crisis therefore gives us the opportunity to study the impact of a large income shock to the family during childhood on long-term health outcomes in context of a developing economy. In addition, the crisis had a number of features which makes it easier to interpret the results we get: First, we will show that it was not accompanied by either important changes in migration patterns or by an increase in infant mortality. We therefore do not need to worry about sample selection in those who we observe in adulthood, unlike what seems to happen, for example, in the case of a famine. Second, it did not result in a change in relative prices, which would have meant that it would spill over into areas that do not grow wine (even the price of wine did not increase very much, for reasons we will discuss below). As a result, we can identify regions that were completely unaffected. Finally, the progression of the epidemic was exogenous, as it was caused by the movement of the insects, which is something no one knew how to stop until the late 1880s.

We find that the Phylloxera shock had a long-run impact on stature: We estimate that children born during a "Phylloxera year" in wine-producing regions are 1.6 to 1.9 milimeters shorter than others. We estimate that this corresponds to a decline in height of 0.6 to 0.9 centimeters for children born in wine growing families in years where their region was affected, a large effect considering that average height grew only 2 centimeters over the entire century. We do not find that children born just before, or just after, the Phylloxera crisis are affected by it, which support the Barker hypothesis of the importance of *in-utero* conditions for long run physical development. However, we also

[8] France lost Moselle, Bas-Rhin, and Haut-Rhin to Prussia in 1870, while retaining the Territoire de Belfort, a small part of Haut-Rhin. Moselle, Rhin-Bas, Haut-Rhin, and Belfort are excluded from the analysis.

do not find any long-term effect on other measures of health, including morbidity at the age of 20 (measured by the military as well) or life expectancy of women.

The remainder of this paper proceeds as follow: In the next section, we describe the historical context and the Phylloxera crisis. In section 3, we briefly describe our data sources (a data appendix does so in more detail). In sections 4 and 5, we present the empirical strategy and the results. Section 6 concludes.

2. Wine Production and the Phylloxera Crisis

Wine represented an important share of agricultural production in 19th century France: In 1863, the year Phylloxera first reached France, wine production represented about one sixth of the value of agricultural production in France, which made it the second most important product after wheat (table 1). Wine was produced in 79 “departments” out of 89, although it was more than 15% of agricultural production in only 40 of them (we refer to these 40 departments below as the “wine-growing” departments).

Phylloxera is an insect of the aphid family, which attacks the roots of grape vines, causing dry leaves, a reduced yield of fruit, and the eventual death of the plant. Indigenous to America, the insects arrived in France in the early 1860s, apparently having traveled in the wood used for packaging (though it is possible that it was actually in a shipment of American vines). By the 1860s, the pest had established itself in two areas of France. In the departments on the southern coast, near the mouth of the Rhône, wine growers first noticed the pest’s effects in 1863, and there are many records of it in the years 1866-1867. In 1869 the pest also appeared on the west coast in the Bordeaux region. The maps in figures 1A to 1D show the progression of the invasion starting from these two points: From the south, the insects spread northward up the Rhône and outward along the coast. From the west, the insects moved southeast along the Dordogne and Garonne rivers and north to the Loire valley. By 1878, Phylloxera had invaded all of southern France, and 25 of the departments where wine was an important production. It reached the suburbs of Paris around 1885.

During the first years of the crisis, no one understood why the vines were dying. As the Phylloxera spread and the symptoms became well-known, it became clear that the disease posed a serious threat to wine growers, and two of the southern departments (Bouches-du-Rhône and Vaucluse) formed a commission to investigate the crisis. The commission found Phylloxera insects on the roots of infected vines in 1868 and identified the insects as the cause of the dead vines. After experimenting with various ineffective treatments (such as flooding, or treatment with carbon bisulphide), what was to be the ultimate solution was discovered in the late 1880s. This solution required wine growers to graft European vines onto pest-resistant American roots. In 1888, a mission identified 431 types of American vines and the types of French soil they could grow in, paving the road to recovery starting in the early 1890s. Eventually, approximately four fifths of the vineyards originally planted in European vines were replaced with grafted vines.

Figure 2 shows the time series of wine production in France from 1850 to 1908. The decline in the first few years reflects the mildew crisis, which affected the vines before the Phylloxera. After a rapid recovery between 1855 and 1859, the production grew until 1877, by which time more than half of wine growing departments were touched by the Phylloxera. The production fell until 1890, when the progressive planting of the American vines started the recovery.

Table 2 shows the importance of the Phylloxera crisis on wine production. Using data on wine production reported in Gallet (1957), we construct an indicator for whether the region was affected by the Phylloxera. Gallet (1957) indicates the year where the Phylloxera aphids were first spotted in the regions. In most regions, however, for a few years after that, production continued to increase (or remained stable), until the aphid had spread. Since we want to capture the fall in wine production due to the insect, we define the "pre-phylloxera" year as the year before the aphids were first spotted, and the indicator "attained by phylloxera" is equal to one every year when wine production was less than 80% of its level in the “pre-phylloxera” year. It is then turned back to zero after 1890, since the grafting solution had been found by then.[9]

We then run a regression of area planted in vines, the log of wine production, and yield, for the years 1852-1892 on year dummies, department dummies, and an indicator for whether or not the region was touched by the Phylloxera in that year. Namely, we run the following specification:

$$y_{ij}=a\, P_{ij}+ k_i+d_j+u_{ij}$$

where y_{ij} is the outcome variable (vine grown areas, wine yield, wine production, as well as wheat production) in department i in year j, P_{ij} is an indicator for Phylloxera, k_i and d_j are department and year fixed effects, and u_{ij} is an error term. The standard errors are corrected for auto-correlation by clustering at the department level.

We also run the same specification after controlling for department specific trends:

$$y_{ij}=a\, P_{ij}+ k_i+t_{ij}+d_j+u_{ij},$$

where t_{ij} is a department specific trend. The results are shown in table 2, panel B. The yield and the production declined dramatically: according to the specification that controls for a department specific trend, the production was 37% lower and the yield was 42% lower during Phylloxera years.

Unfortunately, yearly data on overall agricultural production or department “income” are not available except for a few departments (Auffret, Hau and Lévy-Leboyer, 1981) so we cannot provide a quantitative estimate of the fall in department “GDP” due to the Phylloxera. However, there are reasons to think that there was no substitution towards other activities, so that the decline in wine production led to a corresponding decline in income in the affected departments. Table 2 shows that the area planted with vines did not decline during the crisis, both because many parcels of land that had been planted with vines would have been ill-suited to all other crops and also because most growers

[9] We experimented with other ways of defining the Phylloxera attack as well, with results that are qualitatively similar (although the point estimates clearly depend on how strong the fall in production has to be before a department is considered to be “affected”).

were expecting a recovery. As a result, the decrease in wine production was not compensated by a corresponding increase in other agricultural production: Columns 3 to 5, in the same table, show the results of regressing the production of wheat and the area cultivated on wheat on the Phylloxera indicator, and shows no increase of wheat production compensating the decline in wine production. In the few departments in which the series on agricultural production have been constructed by Auffret et al. (1981), the fall in overall agricultural production does appear to be commensurate with the fall in wine production.

To make up for the shortage of French wine, both the rules for wine imports into France and the making of "piquette" (press cake —the solids remaining after pressing the grape grain to extract the liquids—then mixed with water and sugar) and raisin wines were relaxed. For example, while only 0.2 million hectoliters of wine were imported in 1860s, 10 million hectoliters were imported in the 1880s (for comparison, the production was 24 million hectoliters in 1879). Imports declined again in the late 1890s (Ordish, 1972). As can be seen in figure 1, this kept the price of wine from increasing at anywhere near the same rate as the decrease in production. Price movements thus did little to mitigate the importance of the output shock. Moreover, given the size of the crisis in the most affected regions, farmers could not systematically rely on credit to weather the crisis. In particular, Postel-Vinay (1989) describes in detail how, in the Languedoc region, the traditional system of credit collapsed during the Phylloxera crisis (since both lenders and borrowers were often hurt by the crisis). All of this suggests that Phylloxera was a large shock to the incomes of people in the wine growing regions, and the possibility for smoothing it away was, at best, limited.

3. Data

In addition from the department level wine production data already described, we use several data sources in this paper (the data sets are described in more detail in the data appendix).

First, we assembled a complete department-level panel data set of height reported by the military. Height is widely recognized to be a good measure of general health, and countless studies have shown that it is correlated with other adult outcomes (see Case and Paxson (2006) and Strauss and Thomas (1995) for references to studies showing this in the context of the developing world and, among many others, Steckel (1995), Steckel and Floud (1997), and Fogel (2004) historical evidence on this issue from countries that are now considered developed). France is a particularly good context to use military height data. Since the Loi Jourdan, in 1798, young men had to report for military service in the year they turned 20, in the department where their father lived (all the young men reporting in one department and one year were called a "classe", or military class). They were measured, and since 1836, the data on height was published yearly in the form of the number of young men who fell into particular height categories (the number of categories varied from year to year). These documents also included, for each department and each year, the number of young men exempted and the grounds for exemption (in particular, if they were exempted for disease, the nature of the disease). Using this data, we estimated both parametrically and non parametrically the average height of the 20-year old in each department in each year, as well as the fraction of youth who were shorter than 1.56 meters, the threshold for exemption from military duty (see data appendix for the estimation methods).[10] We also computed the fraction of each military class exempted for health reasons, and created a consistent classification of the disease justifying the exemptions.

The nation-level aggregate data on French military conscripts has been used previously (see, Aron, Dumont and Le Roy-Ladurie (1972); Van Merten (1990), Weir (1997), and Heyberger (2005)). However, this paper is the first to assemble and exploit the data on mean height and proportion of those stunted for all departments and every year between 1872 and 1912.[11] The details of the data construction are presented in the appendix.

[10] Actually 1.56 meters was the highest threshold for exemption that was used---the threshold varied over time.
[11] With the exception of Postel-Vinay and Sahn (2006), which was written concurrently with this article and exploits the same data set.

Moreover, we also conducted original archival work in three departments to collect military data at the level of the canton (the smallest administrative unit after the "commune", or village) in three wine growing departments (Bouches du Rhône, Gard and Vaucluse). The precise height data was not stored at this level, but the canton level data tells us three things: The fraction of people not inducted into the military for reason of height (which is available only until the cohort conscripted in 1901, since the military did not reject anyone based on height after that year), the fraction rejected for reasons of "weakness", and the fraction put into an easier service for the same reason.

We use the data for the years 1872-1912 (corresponding to years of birth, 1852-1892), which span the Phylloxera crisis, as well as the period before and the recovery, since this is the period for which the military data is the most representative of the height in the population. Starting in 1872, everyone had to report for military service. Starting in 1886, everyone's height was published, even if they were subsequently exempted from the military service. Therefore, the data is representative of the entire population of conscripts from 1886 on, and from 1872 to 1885, we are missing the height data for those exempted for health reasons (15%) or for other reasons (25%). We discuss in the appendix what we assume about the height of those exempted to construct estimates that are representative of the entire sample, and using a complete individual level dataset available for a sub-sample, we show that these assumptions appear to be valid. The data should therefore be representative of the entire population of young men who presented themselves to the military service examination in a given region.

This sample may be still endogenously selected if Phylloxera led to changes in the composition of those who reported to the military conscription bureau in their region of birth, either because of death, migration, or avoidance of the military service. According to historians of the French military service (e.g. Woloch (1994)), the principle of universal military conscription was applied very thoroughly in France during this period. A son had to report in the canton where his father lived (even if the son had subsequently migrated) and the father was legally responsible if he did not. Avoidance and migration by the son are therefore not likely to be big issues. As a check, we computed the ratio between the number of youths age 15-19 in each department in each census year, and sum of the sizes of the military cohorts in the four corresponding year years (for example, a youth age 19 (resp, 17) in 1856 was a member in the class of 1857 (resp. 1859): The average is 99% and the standard deviation is low (table 1). Moreover, as we will show in table 8, this ratio does not appear to be affected by the Phylloxera crisis.

The main potential sample selection problems that remain are therefore those of differential migration by the fathers and mortality between birth and age 20. We will show in the robustness section that neither of these seems to have been affected by the Phylloxera infestation.

Finally, we use data on number of births and infant mortality (mortality before age 1), from the vital statistics data for each department and each year and two data series constructed by Bonneuil (1997) using various censuses and records of vital statistics: The first one gives the life expectancy of females born in every department every 5 years, from 1806 to 1901. The second gives the migration rates of females, both for the young (20 to 29 year olds) and for the entire population.

4. Empirical Strategy

4.1 Department-level Regressions

Figures 3 and 4 illustrate the spirit of our identification strategy. Figure 3 shows mean height in each cohort of birth for wine-producing regions (where wine represents at least 15% of the agricultural production) and other regions. Wine-growing regions tend to be richer and, for most of the period, the 20 year old males are taller in those regions than in others. However, as Figure 4 shows very clearly, the *difference* in average height between those born in wine-producing regions and those born in other regions fluctuates. The striking fact in this figure is how closely the general trend in the difference in mean height follows the general trend in wine production. Both grow until the end of the 1860s, decline in the next two decades (when the Phylloxera progressively invades France) and increase again in the 1890s, when wine grafting allows production to again rise.

The basic idea of the identification strategy builds on this observation: It is a simple difference in differences approach where we ask whether children born in wine producing departments in years where the wine production is lower due to the Phylloxera, are shorter at age 20 than their counterparts born before or after, relative to those who are born in other regions in the same year. Likewise, we can ask whether they have worse health (as described by the military, lower life expectancy, lower long term fertility, etc.). The difference in differences estimates are obtained by estimating:

$$(1)\ y_{ij}=a\ P_{ij}+\ k_i+d_j+u_{ij}$$

where y_{ij} is the outcome variable (for example: height at age 20, life expectancy) in departement i in year j, P_{ij} is an indicator for Phylloxera (constructed as explained in section 2, and set to 0 if the department was not a wine producing department[12]), k_i and d_j are department and year fixed effects, and u_{ij} is an error term (following Bertrand, Duflo, and Mullainathan (2004), the standard errors are corrected for autocorrelation by clustering at the department level).

We also run the same specification after controlling for department-specific trends:

$$(2)\ y_{ij}=a\ P_{ij}+\ k_i+t_{ij}+d_j+u_{ij}$$

Also run is an alternative specification where we use a continuous measure of how much a department is affected by the crisis, instead of the dummy: The measure is constructed by interacting the dummy indicating that Phylloxera has reached the department with the area of vineyard per capita before the crisis (we use average area of vineyards over the years 1850-1869, taken from Gallet, as our pre-crisis measure). An alternative continuous measure is the fraction of wine in agricultural production before the crisis, multiplied by the fraction of the population deriving a living from agriculture.[13]

[12] I.e. less than 15% of the agricultural income came from wine before the crisis.
[13] We will argue below that this appear to be a correct approximation of the fraction of people who lived in wine growing families.

Finally, in some specifications, we restrict the sample to those departments where wine represented at least 15% of the agricultural production before the crisis. All these regions were affected by the Phylloxera at one point or another, and in these specifications we therefore only exploit the timing of the crisis, not the comparison between regions that may otherwise be different.

All these regressions consider the year of birth as the year of exposure. But one could easily imagine that the Phylloxera affects the long-run height (or other measures) even if children are exposed to it later in their lives. We will thus run specifications where the shock variable is lagged by a number of years (so it captures children and adolescents during the crisis). For a specification check, we will also estimate the effect of being born just *after* the crisis.

4.2 Canton-Level Regressions: Gard, Vaucluse, Bouches-du-Rhône

With regressions run at the department level, one may worry that any relative decline of height during the Phylloxera crisis is due to some other time varying factor correlated with the infestation. This concern is in part alleviated by controlling for department specific trends, but since we are considering a long time period, it is still conceivable that the trends have changed in ways that are different for regions and cohorts affected by Phylloxera, but for reasons that have nothing to do with the disease. We therefore complement this analysis by an analysis performed at the level of the canton: For three departments in Southern France (Gard, Vaucluse, and Bouches du Rhône) we collected data on military conscripts at the canton level from the archives in each of these departments. Data on wine production is not available yearly at this fine a level, but the area of vineyards was collected for the 1866 agricultural enquiry, and is also available at the canton level in the archives. We will combine this measure of the importance of vine production before the crisis with the indicator for the fact that the department as a whole was hit by the disease as a proxy for the impact of Phylloxera on wine-production.

The specification we use for these departments is as follows:

$$(3)\ y_{ijk}=a\ (P_{ij*}V_k)+ m_k+d_{ji}+u_{ijk},$$

where V_k is the hectares of vineyards in 1866 in canton k, P_{ij} is, as before, a dummy indicating whether department i is affected by the Phylloxera in year j, d_{ji} is a department time year fixed effect and m_k is a canton fixed effect. This specification only compares cantons within the same department, and it fully controls for department times year effects: It thus asks whether young men born in cantons where wine was more important before the crisis suffered more due to the crisis than those born in cantons where it was less important.

4. Results

4.1 Height

Table 3 shows the basic results on the height at age 20, at the level of the department. Depending on the specifications, we find that, at age 20, those born in the Phylloxera years are 1.5 to 1.9 milimeters smaller than others, on average. They are also 0.35 to 0.38 percentage points more likely to be shorter than 1.56 centimeters. In panel C and D, we use the continuous measure of exposure to the Phylloxera (hectares of vineyards per capita), first in the entire sample and, in order to check that the results are not driven solely by the contrast between wine-producing and non wine-producing regions, in the sample of departments where wine is at least 15% of agricultural production. We find that, in wine-producing regions, one more hectare of vine per capita increases the probability that a 20 year old male is shorter by 3% and reduces his height by 1 centimeter. If instead, we use data from all the regions, the effects are respectively 1.85% and 7 milimeters.

The best way to scale the effect of the Phylloxera crisis would be to use the fraction of the population living in wine producing households. There is, unfortunately, no data source on this. To proxy it, we use the product of the share of wine in agricultural income before the crisis (in 1862) and the share of the population living in households whose main occupation is agriculture. This would be an overestimate of the fraction of population living in wine producing households[14] if the output per worker was higher for wine than for other agricultural products. Estimates based on the cross-department variation in output per worker and share of wine in agricultural production suggest, however, that the output per worker in wine and non wine production is similar, so that the coefficient of this variable can then be interpreted as the effect of the crisis on wine growing families. We show this specification in panel E (for all regions) and F (for wine producing regions only). The regressions indicate that a child born of a wine producing family during the Phylloxera crisis was 0.5 to 0.9 centimeters smaller by age 20 than he would otherwise have been. This is not a small effect, since heights in France grew only by 2 centimeters in the entire 19th century: In term of stature, being born during the Phylloxera crisis in a wine producing region was equivalent to losing almost half a century worth of growth.

Table 4 shows the results of the specification at the canton level of the 3 wine-producing departments. The results can be directly compared to the results in panel C and D of table 2, since, as in that table, the explanatory variable is the number of hectares of vines divided by the population. One difference is that the data are only available for men born until 1881, and the other is that the threshold for being rejected is not 1.56 meters, but 1.54 meters. This specification also suggests a significant impact of the Phylloxera on height: We find that the probability of being rejected for military service because of height was 1.3% higher for each additional hectare of wine per capita. This is a somewhat smaller number than what we found in the department-level specification, but the two numbers are not statistically different, and are of the same order of magnitude. The fact that this specification, which uses a much finer level of variation, provides results that are consistent with the department-level results, is reassuring.

Table 5 investigates the effects of the Phylloxera on various regions and cohorts. Columns 1 to 4 estimate the effect of the Phylloxera on various cohorts. Column 1 is a specification check: We define a "born after Phylloxera" dummy, and confirm that those born immediately after the Phylloxera epidemics are no shorter than those who were born

[14] Which would lead to an underestimate of the effect of the Phylloxera when we use this variable.

before. This is another element suggesting that the effect is probably not due to an omitted changing trend. Column 2 examines the effect on those who were young children (1 to 2 year olds), or toddlers (2 to 5 year olds) at the time of the epidemic. Interestingly, we find no long-run effects on them. Finally column 3 looks at the effect on those who were teenagers during the crisis, and finds again no effect on them. It seems that the shock had no long lasting effects if it was experienced later in childhood.

Column 4 presents another specification check: We run a specification similar to equation (2) (with the dummy set to 1 for regions where wine represents at least 15% of agricultural production), but we also include a Phylloxera dummy for regions that produce less than 15% of wine. Vineyards in those regions were also affected by the Phylloxera (so that the "Phylloxera" variable can be defined as for all regions) , but we do not expect this to really affect average height, since wine did not affect most of the people in this region. Indeed, the coefficient of the Phylloxera dummy in regions producing little wine is insignificant (and slightly positive).

Column 5 separates the regions that were affected early and those that were affected late (we code as "early" regions where the Phylloxera was first spotted before 1876, the median year at which it reached the regions). Since the disease was progressing slowly from one region to the next, the regions affected later might have been able to anticipate the crisis, and thus avoid a part of the negative impact. This is not what we find: The effect seems to be just as large in regions affected later on.

4.2 Other Health Indicators

While height is an important indicator of long run health, it is also important to estimate whether the Phylloxera affected more acute indicators of health, both in the short run (infant mortality) and in the longer run (morbidity, life expectancy).

4.2.1 Mortality and Life Expectancy

Our next measure of health is the life expectancy of those born during the Phylloxera periods. To study this question, we take advantage of data constructed by Bonneuil (1997), from censuses and corrected vital statistics. Bonneuil constructed with great care life expectancy at birth for women born every 5 years from 1801 to 1901.[15] In column 1 of table 6, we use this variable as the dependent variable, still using the specification from equation (2). We find no impact on life expectancy.

Another (cruder) measure of mortality is given by our data: Since after 1872, everyone age 20 was called for the military service and since, as we will show below, it does not appear that there was selective migration out of the Phylloxera departments, a proxy of survival by age 20 for males is given by the size of the military cohort (*classe*), divided by the number of births in that cohort (column 3). This measure also shows no effect of Phylloxera. We also construct the ratio of the size of the *classe* and the number of children who have survived to age 1 (column 4), and again see no effect. Finally, column 6 presents the results on infant mortality (mortality before 1). There again, we find no impact.

4.2.2 Military Health Data

To investigate the size of the impact of the Phylloxera infestation on health, we then exploit the data collected by the military on those exempted for health reasons, and the reasons for which they were exempted. We use the same specification as before, with the total number of people exempted, and then the number of people exempted for various conditions, as dependent variables. We use the specification in equation (2) (with department-specific trends).

Column 1 of Table 7 displays a surprising result: The number of young men exempted for health reasons is actually *smaller* for years and departments affected by the phylloxera outbreak. However, the following columns shed light on this surprising result:

[15] Focusing on women avoids biasing the results due to the massive mortality of men during the first world war.

The incidence of all the precisely defined illnesses (such as myopia, goiter, epilepsie etc.) are in fact unaffected. The only category of health condition that are affected are that of "faiblesse de constitution" (or weakness) and hernia. Weakness is clearly something that is subject to interpretation and one very plausible explanation for what we find is that, faced with the necessity of drafting a fixed number of people for the contingent, the military authorities were stricter with the application of the "weak" category at times where they were rejecting more people for reasons of height. The negative effect on hernia is more puzzling, but could be due to the fact that these cohorts performed less hard physical labor at young ages.

Overall there seems to be no clear evidence of a negative long-run impact of Phylloxera on any health condition: While it affects long-run height, it seemed not to cause any other physical problems. The conclusion is similar when using "canton" level data (table 4), in the three wine producing regions. In this data, we have the number of people exempted from military service because of weakness. If we consider the years until the year of birth 1881 (class of 1901), there is no impact of the Phylloxera on exemption for weakness. After 1901, however, the military adopted a policy of not rejecting anyone because of height and when we include the post 1901 period, we do see an increase in the number of those exempted for weakness during the Phylloxera period. This suggests that after 1901 some of those who would have been exempted based on their height were now exempted based on being labeled as weak, another indication of the permeability of those two categories.

4.3. Robustness to Sample Selection

Table 5 presented a number of specification checks confirming the fact that those conscripted 20 years after the department where they reported was affected by Phylloxera, are shorter than others born in other years. However, as we have pointed out above, while a strength of the military data is that it covers a large sample of the male population, there are some reasons to worry about selection biases. The main source of potential selection bias comes from the composition of the military class (the cohort who was drafted in each department in each year), and whether it is representative of all the children born in the department, or of all the children that would have been born in the department in the absence of the Phylloxera.

Selection could arise at several levels. First, there could be fewer births during the Phylloxera period, either due to fewer conceptions or to more stillbirths. The “marginal” (unborn) children could be different than the others, in particular they could have been weaker, had they lived. We regress the number of live births in a year, as well as the ratio of stillbirths to total births in the Phylloxera years in table 6 (columns 2 and 5). There does not appear to be an effect on the number of births.

Second, there could be more infant mortality in the Phylloxera years, thus selecting the “strongest” children. However, we have seen in table 6 that life expectancy and the ratio of the size of the class over the number of births, or the number of survivors by age 1, were unaffected.

Third, children born in Phylloxera years may have been less likely to report for service where they were born. Since they have to report in the place their parents live, this would be due either to avoidance by the child or to migration of the children’s parents: Some people may have left the affected regions during these years. Table 8 shows some evidence showing that neither avoidance, nor migration, is likely to be biasing our results: To get a measure of avoidance, we construct the ratio of the size of five subsequent military cohorts on the size of the census cohorts for people age 15-19 (as discussed above, the mean of this ratio is 99%). As shown in column 3 of table 9, this is no different for children who were affected by the Phylloxera, suggesting they were no more likely to avoid military service. Finally, columns 1 and 2 use data constructed by Bonneuil on the migration of women. We use the fraction of women aged 20-29 and aged 20-60 who migrated as dependent variables. There appears to be no effect of the Phylloxera on migration out of the affected departments. This does not mean that people did not migrate at all: In the three departments for which we have canton-level data, we find that find that the classes born in Phylloxera years are smaller in the *cantons* that relied more intensively on wine production (column 4, table 4). This, combined with the fact that we see no migration out of the departments, suggest that some of the families may have migrated out of the wine producing cantons but remained in the department.[16]

5. Conclusion

The large income shock of the Phylloxera had a long-run impact on adult height, most likely due to nutritional deficits during childhood. We estimate that children born in affected regions during the years of the crisis were 0.5 to 0.9 centimeters shorter than their unaffected peers. This is a large effect, considering that height increased only by two centimeters over the period. Similar results are obtained when comparing departments with each other or when using data at a lower level of aggregation, the canton, which reinforces our confidence in their robustness. The effects are concentrated on those born during the crisis, and imply that they suffered substantial nutritional deprivation in-utero and shortly after birth, and those had long term impact on the stature they could achieve.

However, this crisis did not seem to result in a corresponding decline in other dimensions of health, including mortality, even infant mortality. This suggests, as suggested by Deaton, Cutler and Lleras-Muney (2006) that despite the shock to income and corresponding decline in nutrition, health status may have been protected by other factors, for example public health infrastructure (see Goubert (1989) on the importance of clean water in the period).

[16] A regression of the urbanization rate on the Phylloxera dummy (controlling as usual for department dummies, year dummies, and specific department trends) suggests indeed that urbanization progressed significantly faster in Phylloxera years in the affected departments.

Appendix: Data sources and construction[17]

This article relies on a number of data sources, often assembled in electronic form for the first time. We are pleased to make all the data available for distribution. This appendix details the sources and the procedures followed to construct the data.

1. Wine and wheat production

   a. Aggregated data on wine production

The aggregate data on wine and production comes from Statistique Générale de la France, Annuaire Statistique, 1932, Paris, Imprimerie Nationale, 1933, p, 55*-56*.

   b. Department level wine production and Phylloxera Crisis

The source is: Pierre Galet's *Cépages et Vignobles de France* (Galet, 1957) which gives yearly the area planted in vines and the volume of wine produced in almost every wine-growing department from 1860-1905. We used the yearly series on wine production as is. We computed a measure of pre-phylloxera area planted in wine by computing the average surface planted in vine during the years 1850-1869. We also obtain from Galet the year of the first time the Phylloxera was spotted in every important wine-growing department.

   c. Department level yearly series on wheat production

From 1852 to 1876, the data comes from : Ministère de l'Agriculture et du commerce *Récoltes des céréales et des pommes de terre de 1815 à 1876*, Paris, Imprimerie Nationale, 1878. From 1877 onwards, it comes from Statistique Générale de la France, *Annuaire Statistique*, 1932, Paris, Imprimerie Nationale, 1878--.

   d. Canton level data on wine production pre-phylloxera

We use the data on wine surface from the Agricultural Inquiry of 1866 (Ministère de l'Agriculture, du Commerce et des Travaux Publics, Enquête agricole, 2° série, enquêtes départementales, 22° et 23° circonscription, Paris, 1867), which are available at the level of the canton.

2. Population data

   a. Department level population

[17] (Note to referees: The data appendix could remain on-line if is not necessary in the print version.)

The population (and the agricultural population) of each department was obtained from the 1876 census. Statistique de la France: Résultats généraux du dénombrement de 1876. Paris, Imprimerie nationale, 1878.

b. Canton level population

The data on the population of cantons was taken from the military data (see below). The wine superficie in 1866 was normalized by the canton population in 1872.

c. Births and deaths

Total number of births, stillbirths, and total number of deaths before age 1 are obtained from the vital statistics, reported annually in "Statistique Générale de la France: Annuaire statistique de la France, Paris, Imprimerie nationale" (various years). We computed infant mortality as the number of deaths before the age of 1 divided by the number of births during the previous year. As Bonneuil (1992) describes in detail, both the data on births and deaths are noisy, and the data has very large outliers. We exclude from the raw series the observations where the infant mortality is in the bottom percentile or the top percentile. This does not remove any department but removes a few very low or very high observations in some departments.

3. Military height and health data

a. Sources: Department level data

The department level data is reported yearly (since 1836) in the yearly publications "Compte rendu sur le recrutement de l'armée". Young men born in a given year, for example 1852, formed the "classe of 1872". They were normally examined early the following year, at the age of between 20 years plus 8 months on average (plus or minus 6 months depending on the date of birth). They were measured and received a medical exam.

Before 1871, not everyone was called for the military service: Each young man received a random number, and people were examined in random order until the size of the "contingent" (active army) needed for the year was filled. It was also possible to exchange with someone else. The size of those exempted for health reasons was not reported.

The data becomes clearer after a 1872 law (following the defeat of Germany) which changed the nature of the military service: Everyone was now called, and replacements were not allowed. The statistics also reported the height of a much larger fraction of the class. There are two periods in the data:

1) From 1886 to 1912: Things are very simple. Every young man was examined, and a summary table reported the distribution of height for the *entire cohort* (as the number of people falling into various bins—the number of bins varied from 10 to 26.
2) From 1872 to 1885:

- Every young man was called to be examined. From 1872 to 1885, a “classe” was about 300,000 young men. Only about 10,000 per year did not present themselves (3%), and were therefore not measured.
- Among those who were measured
    1. A fraction (about 50% of the cohort) was put in the “contingent”, or active service. Their height is recorded in bins in the table “contingent”.
    2. A fraction (10%) was put in a category “auxiliaire” (they were asked to do an easier military service). Their height is recorded in bins in the table “auxiliaires”, with the same category as the table for the contingent.
    3. A fraction (7%) was put in a category “ajournés” (they were asked to sit out and to go be examined again the following year—fortunately, their data was not aggregated with that of the rest of the contingent the following year). A number of them were “ajournés pour défaut de taille” (too short), and we therefore know that they are smaller than the height threshold in those years (1.54m). A number were “ajournés pour faiblesse de constitution” (weakness) and following Weir (1997) we assume that they are taller than the minimum threshold (otherwise, they would have been “ajournés pour défaut de taille”, and that they are otherwise distributed like the rest of the population above this threshold. They represents only a fairly small fraction of the population (about 5%).
    4. A fraction (another 10% of the population) was put in a category “exemptés” (exempted) for health reasons. Still following Weir (1997) we assume that their height has the same distribution as the rest of the population.
    5. A fraction (about 25% of the population) was “dispensés”, and did not need to do the military service, for reasons other than health (priests, sons of widows, etc. where put in this category). Their height was not reported in the summary descriptive either, and we assume that their height as the same distribution as the rest of the population.

Fortunately, since everyone was measured, it is possible to check some of these assumptions (which this paper is the first to do). Farcy and Faure (2003) collected individual level military data on about 50,000 young men born in 1860 (classe of 1880) in Paris and a few other departments. Figure A1 compares the distribution of height of the those who serve in the active service to that of the “dispensés” (25% of people exempted from the military service for reasons other than health).[18] The distributions are right on top of each other. Figure A2 compares those exempted for health reasons to the entire observed population (dispensés+auxiliaires+ajournés). While the correspondence is less perfect (the distribution of height of the exempted has less mass at the mode), the median

[18] For both figures we estimate the distribution with a kernel density estimator, using an Epanechnikov Kernel and a bandwidth of one centimeter.

of the two distribution are the same (165 centimeters) and the means are also extremely close (165.09 centimeters for the exempted, and 165.26 centimeters for the rest of the population). This suggests that the approximations that are done in this paper are acceptable.

- There was a last complication: From 1872 to 1885, the aggregate data was not reported at the level of the department, but at a smaller level (military district). We entered the data at that level and re-aggregated at the department level.

b. Sources: Cantons level data

The height data were published after aggregation at the level of the department, but some data was also tabulated at the level of the "cantons". The yearly reports ("Comptes statistiques et sommaires) are kept in the departmental archives, where we collected them for three departments: Gard, Vaucluse, and Bouche du Rhône. The height distribution was not tabulated at that level, but the population of the canton, the number of youth placed in auxiliary service, the number of youth asked to sit out because they were too short, and the number of youth placed in the active service was recorded. Note that we lose this information after the class of 1881, since height stopped being a reason for exemption at this time.

c. Computations methods

The records on height provide data in a summary form, giving the number of conscripts in height bins of various widths—for example the number of those between 1.54 and 1.63 meters or those between 1.67 and 1.70 meters. Men shorter than the minimum height requirement were exempt from service, and listed as "*défaut de taille*" (lack of height) in the exemption statistics, resulting in left-censored data.[19] The data are in fact double-censored, since the final category includes conscripts above a certain height, 1.73 meters for example. Between 1850 and 1912 the number of categories changes several times, reaching a maximum of 28 from 1903-1912 and a minimum of 9 from 1872 to 1900.

We estimate the departmental distributions of height two ways. First, we assume that the distribution is normal and estimate the parameters of the distribution by maximum likelihood estimation. The log likelihood function is maximized using a simplex search algorithm using starting guesses of 1.66 meters for the mean height and 0.04 meters for standard deviation.[20] Provided the assumption of normality holds, this technique yields

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[19] The minimum height is 1.56m from 1832 to 1871 and 1.54m from 1872 to 1900. From 1901 on there is no minimum height requirement.

[20] The general form of the log likelihood function for this data is

$$L = c_1 * \ln\left(\Phi\left(\frac{x_1-\mu}{\sigma}\right)\right) + \sum_{i=2}^{n-1}\left(c_i * \ln\left(\Phi\left(\frac{x_i-\mu}{\sigma}\right) - \Phi\left(\frac{x_{i-1}-\mu}{\sigma}\right)\right)\right) + c_n * \ln\left(1-\Phi\left(\frac{x_{n-1}-\mu}{\sigma}\right)\right)$$

where n is the number of height categories, c is the number of observations in each category, and x is a boundary between categories and phi is the standard normal cdf.

efficient estimates of the means and variances of the distributions. We use the mean of the distribution estimated following this procedure.

While height typically follows a normal distribution among adult populations (and the graphs we just discussed indeed appear to be normal), the distribution of height among French conscripts may differ from a normal distribution. In particular, if the Phylloxera crisis did affect the long term health, it could result in a distorted distribution. In a population with varying levels of initial health, an income shock might therefore not simply shift the distribution; it could have bigger effects at the tails. Imposing a normal distribution on affected regions may obscure these effects.

We therefore also estimate the height distributions non-parametrically. For each department-year cell, the number of observations equals the number of height categories. Each category is assigned the value of the mean of its limits and weighted by its count of conscripts. The extreme lower and upper categories are assigned values one centimeter below and above the censoring points. Using a kernel density estimator, we estimate the PDF evaluated at fifty evenly spaced heights.[21] Riemann summation transforms the points of the PDF into a CDF, and we interpolate to find the deciles of the distribution. We use this estimated data to compute a uniform series for the percentage of individuals measured who are shorter than 1.56 meters (very short), which we use as an alternative dependent variable.

4. Life Expectancy and Migration

The life expectancy and migration data were constructed by Bonneuil (1997) from vital statistics and census data, that he very carefully corrected to provide consistent data.

[21] We use a Gaussian kernel with optimal bandwidth approximated by $h = \frac{0.9m}{n^{1/5}}$, where m is the sample variance of the midpoints of the height categories and *n* is the number of categories.

Table 1: Summary Statistics

	Mean	Std. deviation	Observations
	(7)	(8)	(9)
Superficie grown in wine (hectare)	28205	33549	2165
Log wine yield (value per hectare)	2.55	0.83	2153
Log(wine production) (value)	12.03	1.87	3088
Log(wheat production) (value)	13.66	0.89	3209
Share of wine in agricultural production (1863)	0.15	0.14	3649
Share of population working in agriculture	0.58	0.15	3526
Superficie grown in wine per habitant	0.07	0.09	3769
Share of populationin agriculture* share of wine in agricultural Production	0.09	0.08	3526
Number of live births	10751	8593	2795
Share of males surviving untilage 20	0.69	0.23	2683
Share of males surviving until age 20 (conditional on surviving till 1)	0.85	0.29	2599
Share of still births	0.04	0.01	2795
Infant mortality (death before age 1/live birth)	0.17	0.04	2486
Life expectancy (women)	44.34	4.55	630
Net outmigration of youth age 20-29	-0.02	0.05	690
Net outmigration (all)	-0.02	0.02	690
Military class size	3567	2708	3526
Military class/census cohort aged 15-19	0.99	0.27	504
Proportion exempted for health reasons	0.24	0.07	3354
Mean height of military class at 20	1.66	0.01	3526
Fraction of military class shorter than 1.56 meters	0.05	0.02	3526
Height of percentile 10	1.57	0.01	3526
Height of percentile 20	1.59	0.01	3526
Height of percentile 25	1.60	0.02	3526
Height of percentile 50	1.65	0.01	3526
Height of percentile 75	1.69	0.01	3526
Height of percentile 80	1.70	0.01	3526
Height of percentile 90	1.72	0.01	3526

Notes:

1-Except when otherwise indicated, this table presents average by department of the variables used in this paper over the years 1852-1892 (corresponding to the military classes 1872-1912, and years of birth 1852-1892

2- Data sources are described in details in the data appendix

Table 2: Impact of phylloxera on wine area and wine production

	wine			wheat		
	log(area)	log(yield)	log(production)	log(area)	log(yield)	log(production)
	(1)	(2)	(3)	(4)	(5)	(6)
A. Controls: Year Dummies, Departement dummies						
Phylloxera	-0.126	-0.349	-0.399	0.025	-0.009	-0.011
	(.072)	(.055)	(.108)	(.024)	(.026)	(.035)
Observations	2165	2153	3088	1020	1020	3172
B.Controls: Year dummies, departement dummies, departement specific trend						
Phylloxera	-0.090	-0.478	-0.558	0.014	-0.024	0.037
	(.062)	(.071)	(.104)	(.018)	(.025)	(.027)
Observations	2165	2153	3088	1020	1020	3172
C. Sample restricted to wine producing regions (with department specific trend)						
Phylloxera	-0.071	-0.523	-0.570	0.006	-0.010	0.040
	(.062)	(.082)	(.116)	(.016)	(.027)	(.03)
	1058	1051	1519	456	456	1433

Note:
1-Each column and each panel present a separate regression
2-All regressions include department dummies and year dummies
3-Standard errors corrected for clustering and auto-correlation by clustering at the department level (in parentheses below the coefficient)
4- Importance of wine in production in a department is defined as
share of wine in agricultural production*share of population in an agricultural family
5-There are fewer data points in this regressions than in the next tables, because the data on wine and wheat production is not available for every department in every year.

Table 3: Impact of phylloxera on height at 20

	Dependent Variables	
	Mean height	Fraction shorted than 1.56 meter
	(1)	(2)
A. Year Dummies, Departement dummies		
Born in phylloxera year	-0.00150	0.00358
	(.00093)	(.00204)
Observations	3485	3485
Department trend	No	No
B.Year dummies, departement dummies, departement trend		
Born in phylloxera year	-0.00188	0.00381
	(.00095)	(.00173)
Observations	3485	3485
Department trend	Yes	Yes
C. Hectare of vine per habitant		
born in phylloxa year *hectare	-0.00753	0.01928
vine per habitant	(.00389)	(.01142)
Observations	3485	3485
Department trend	Yes	Yes
D. Hectare of vines per habitant (wine producing region only)		
born in phylloxera year*hectare	-0.01101	0.03074
vine per habitant	(.00422)	(.01352)
Observations	1558	1558
Department trend	Yes	Yes
E. Share of population in wine growing families		
born in ohylloxera*	-0.00551	0.01198
Importance of wine	(.00392)	(.00985)
Observations	3485	3485
Department trend	Yes	Yes
F. Share of population in wine growing families (wine producing regions)		
Phylloxera*	-0.00901	0.02257
Importance of wine	(.00459)	(.01228)
Observations	1558	1558
Department trend	Yes	Yes

Note:
1-Each column and each panel present a separate regression
2- The dependent variables are mean height (or proportion shorter than 1.56 meters among a military class in a department and year)
2-"Born in Phylloxera year" is a dummy equal to 1 if the department was affected by phylloxera in the year of birth of a military cohort (see text for the construction of this variable)
3-All regressions include department dummies and year dummies
4-Standard errors corrected for clustering and auto-correlation by clustering at the department level (in parentheses below the coefficient)
5- The share or population in wine growing families is estimated, as described in the text

Table 4: Effect of phylloxera on height, weakness, and exclusion for other reasons
Canton-level regression for three Departments

	Dependent variable: Canton-level means			
	Fraction rejected for size	Fraction rejected for weakness		Class size
	(1)	(2)	(3)	(4)
Hectare of vine per habitant in canton	0.01498	0.00033	0.01664	-64.38
*phylloxera was present in department in year of birth	(.0074)	(.0186)	(.0081)	(37.52)
Observations	2040	2040	2590	2610
Department*year fixed effect	Yes	Yes	Yes	Yes
Canton fixed effects	Yes	Yes	Yes	Yes
Sample	1852-1881	1852-1881	1852-1891	1852-1892
Mean of dependent variable	0.019	0.090	0.10	147
Standard deviation of dependent variable	0.019	0.056	0.06	291

Notes:

1-Data source: archival canton-level data collected by the authors for three departments affected by the phylloxera: Vaucluse, Gard, and Bouches du Rhone

2-The data set contains canton-level data for these three department for the years 1852-1891

2-All the regression include separate fixed effects for each year in each department and canton fixed effects

3- All standard errors (in parentheses below the coefficient) are clustered at canton-level

Table 5: Who is affected?

	Dependent variables									
	Mean Height at 20					Fraction shorter than 1.56 meters at 20				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Born in phylloxera year	-0.00220	-0.00177	-0.00170	-0.00301	-0.00186	0.00550	0.00305	0.00349	0.00302	0.00221
	(.00119)	(.00093)	(.00091)	(.00121)	(.00084)	(.00239)	(.00181)	(.00173)	(.00229)	(.0017)
Born 1 to 5 years after phylloxera	-0.00108					0.00563				
	(.00171)					(.00626)				
Born 1 to 2 year before phylloxera		0.00000					-0.00183			
		(.00091)					(.00127)			
Born 2 to 5 years before phylloxera		0.00079					-0.00384			
		(.00119)					(.0011)			
Born in phylloxera year, region affected early										0.00705
										(.00218)
Born in phylloxera year, region producing little wine				0.00127					0.00088	
				(.00081)					(.00176)	
Teenager during phyloxera			0.00127					-0.00222		
			(.00083)					(.00104)		
Number of observations	3485	3485	3485	3485	3485	3485	3485	3485	3485	3485

Notes:
1-All regressions include year of birth dummies, department dummies, and department specific trends
2-All standard errors (in parentheses below the coefficient) are accouting for clustering and autocorrelation by clustering at the department level

Columns 1 and 2: pretty obvious specifications
Column3: introduce dummy and dumigh, and these are the coefficients
Column 4: reg X codes_* year_* dumhigh dumearly, cluster(code)

Table 6: Impact on fertility, mortality, and life expectancy

	Life expectancy (women)	Live births	Class size /live births in birth year	Class size /survivors at age 1	Still births/all births	Infant mortality (before age 1)
	(1)	(2)	(3)	(4)	(5)	(6)
Born in phylloxera year	0.5087	-39	-0.0025	-0.0082	-0.0004	-0.0033
	(.3604)	(76)	(.0062)	(.0087)	(.0005)	(.0024)
	622	2763	2651	2568	2763	2461

Notes:

1-All regressions include year of birth dummies, department dummies, and department specific trends

2-All standard errors (in parentheses below the coefficient) are accouting for clustering and autocorrelation by clustering at the department level

3- Data on life expectancy for women used in Column 1 is from Bonneuil (1997).

4-Data on live births, infant mortality, and still births obtained from vital statistics

5-Data on class size obtained from mility record. A class observed in year t was born in year t-20

Table 7: Effect on health outcomes, military data

	Exempt due to health	Myopia	Goiter	Hernia	Spinal problem	Epilepsy	Low IQ	Feeble	Blind	Deaf
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Born in	-0.0081	-0.00012	-0.00010	-0.00092	-0.00025	0.00001	0.00020	-0.00218	0.00008	0.00020
Phylloxera year	(.0044)	(.00014)	(.00014)	(.00032)	(.00028)	(.00011)	(.00023)	(.00077)	(.00012)	(.0001)
Number of observations	3315	3485	3485	3485	3485	3485	3485	3485	3485	3485

Notes:

1-All regressions include year of birth dummies, department dummies, and department specific trends

2-All standard errors (in parentheses below the coefficient) are accouting for clustering and autocorrelation by clustering at the department level

Table 8: Migrations and Phylloxera

	Net out-migrations, 20-29 (women)	Net out-migrations 20-60 (women)	Corresponding class size / size of cohort age 15-19 (men)
	(1)	(2)	(3)
Born in Phylloxera year	0.00072	-0.00068	0.006319
	(.004097)	(.00243)	(.04721)
	852	852	498

Notes:
1-All regressions include year of birth dummies, department dummies, and department specific trends
2-All standard errors (in parentheses below the coefficient) are accouting for clustering and autocorrelation by clustering at the department level
3-Data in Column 1 and 2 are obtained from Bonneuil (1997) (one observation per department and per census year); see data appendix
4-Data in column 3 computed by authors from censuses and military cohort data: to a cohort of young men aged 15-19
in year t in department j, corresponds the sum of the "classes" of years' t+1, t+2, t+3, t+4 and t+5.

Figure 1A: Phylloxera in 1870

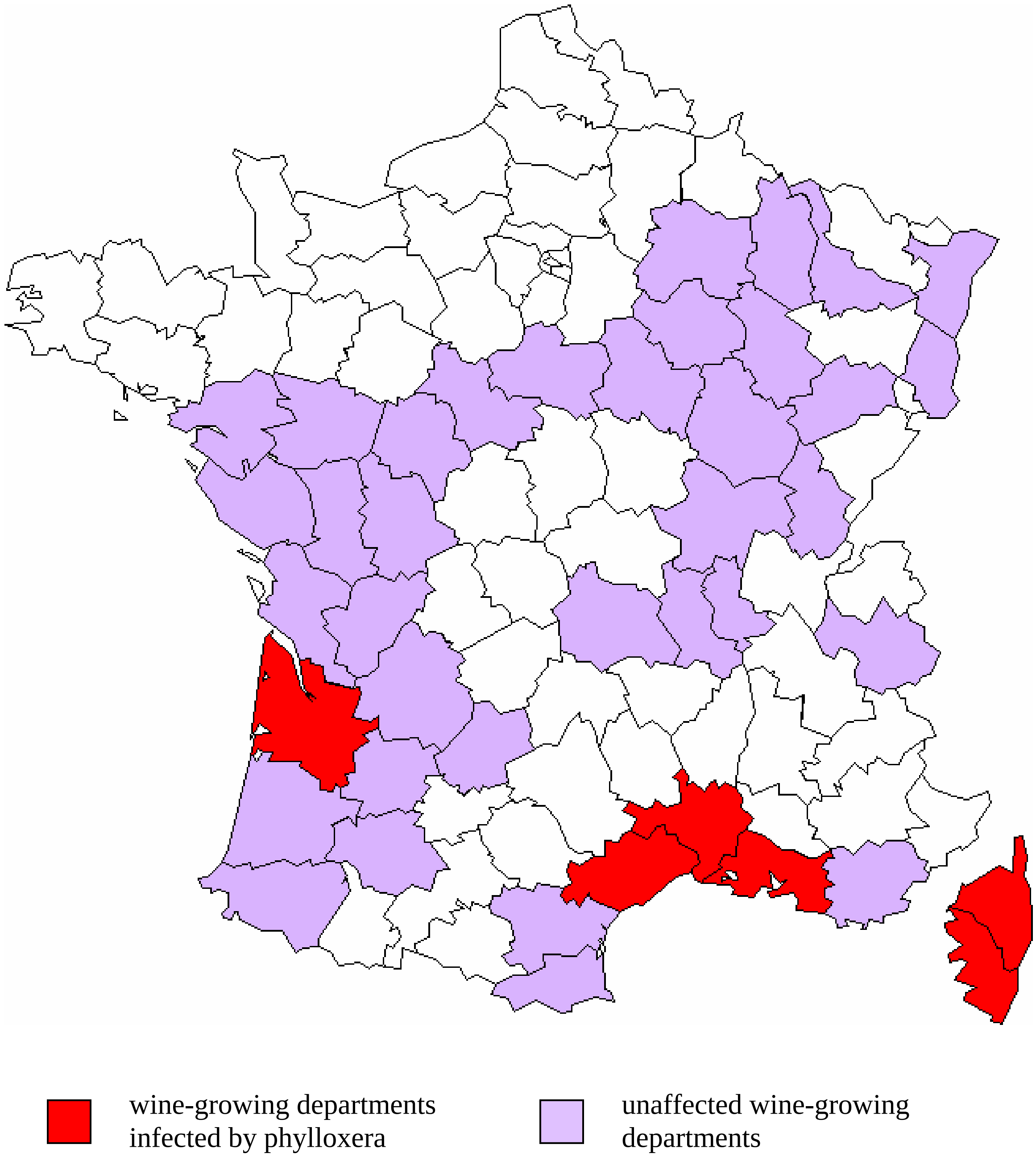
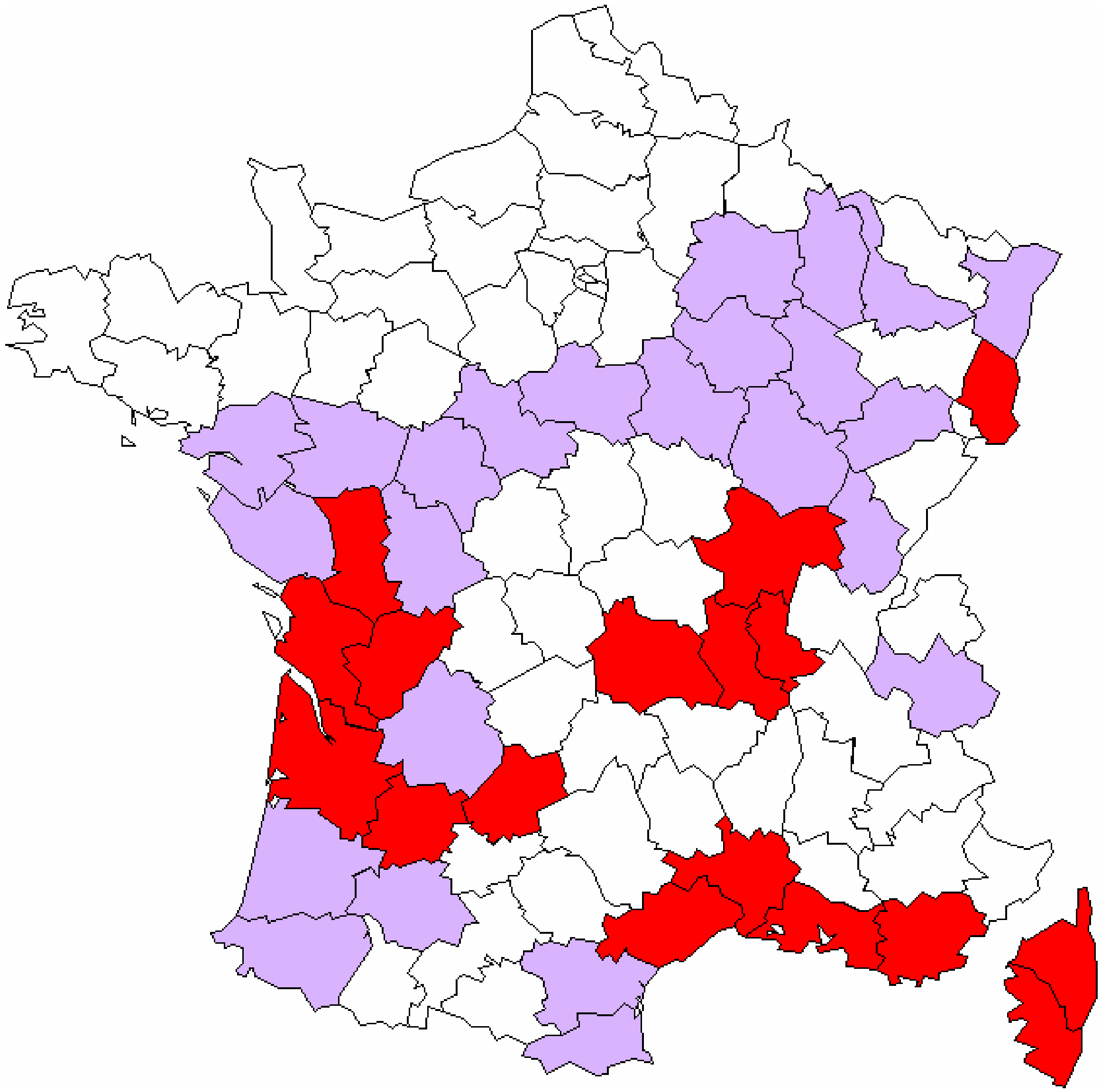


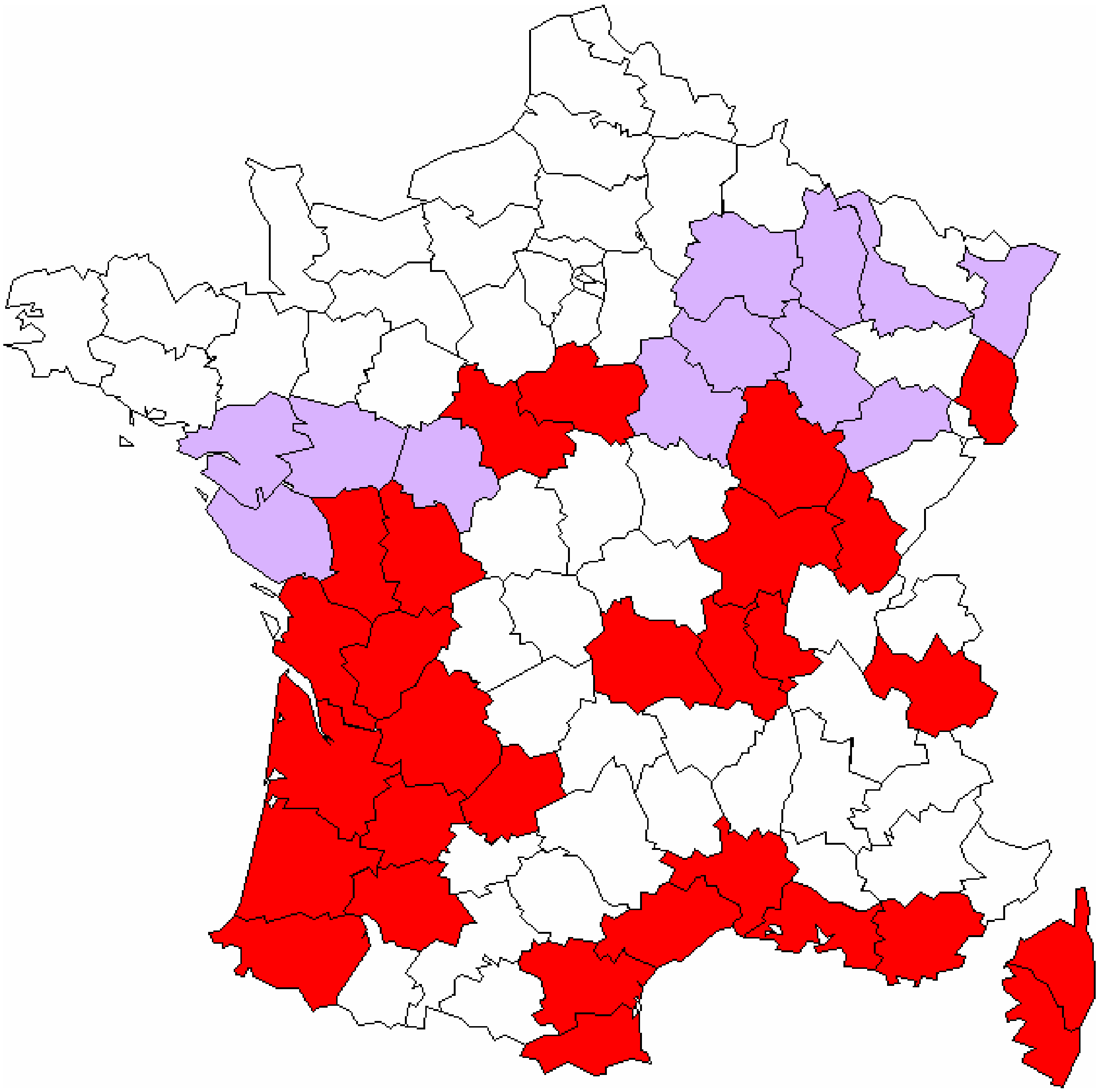
Figure 1B: Phylloxera in 1875

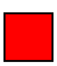


wine-growing departments infected by phylloxera

unaffected wine-growing departments

Figure 1C: Phylloxera in 1880



 wine-growing departments infected by phylloxera

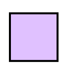
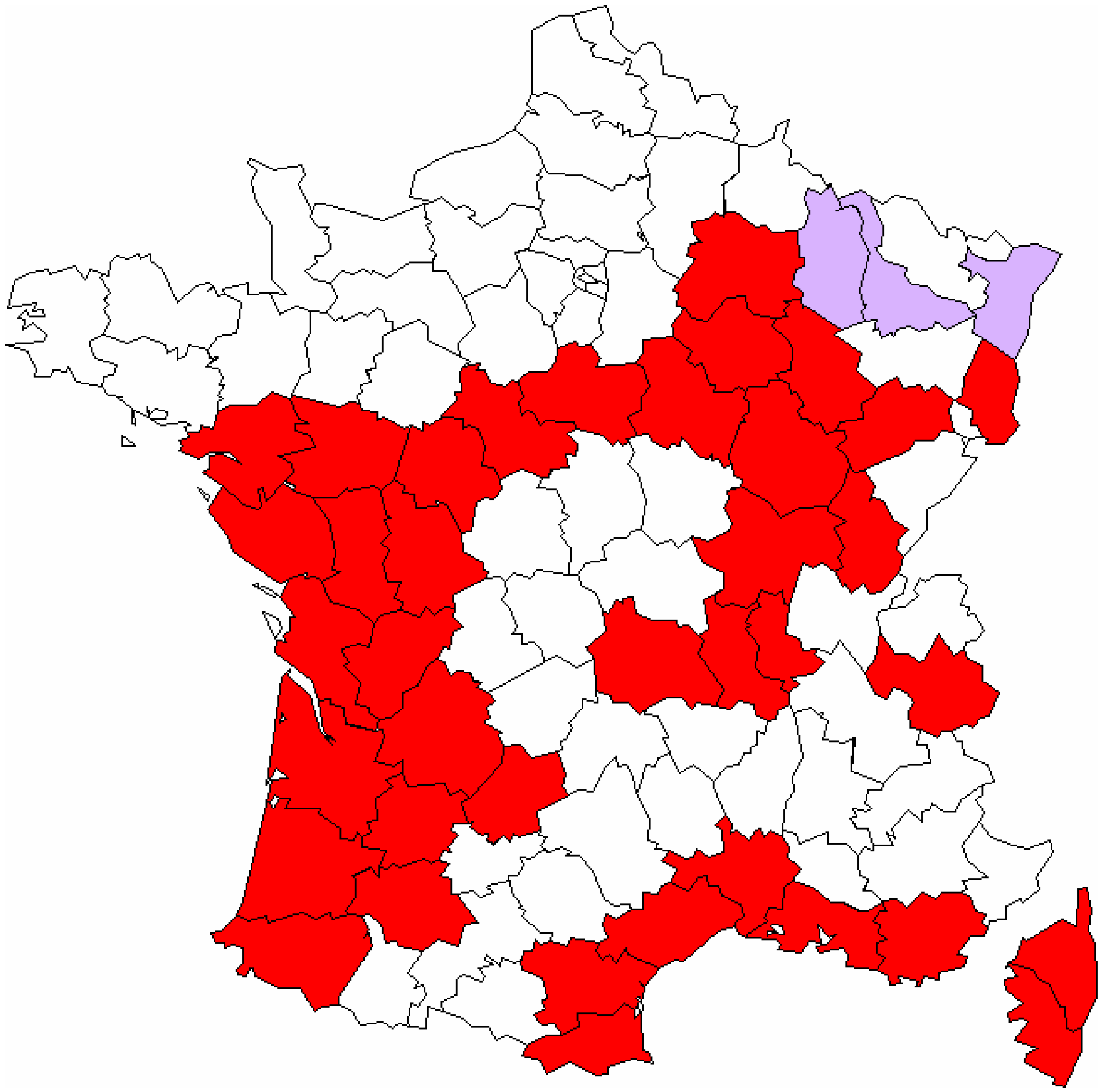
 unaffected wine-growing departments

Figure 1D: Phylloxera in 1890



wine-growing departments infected by phylloxera

unaffected wine-growing departments

Figure 2: Wine Production and Wine price

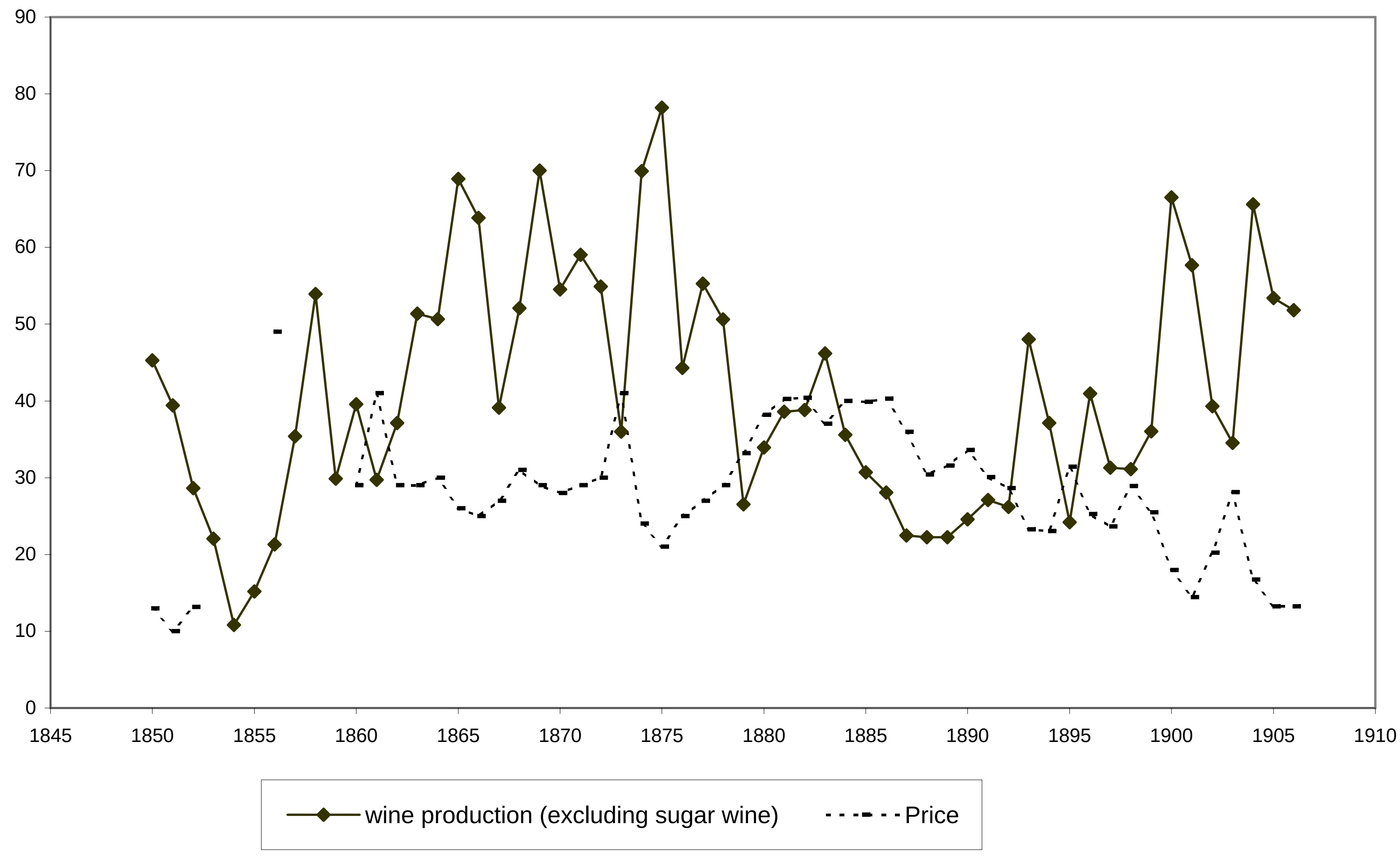


Figure 3: Mean height over time: Wine producing regions and others

Figure 4: Wine production and height differentials

Figure A1: Height Distribution in Individual Data

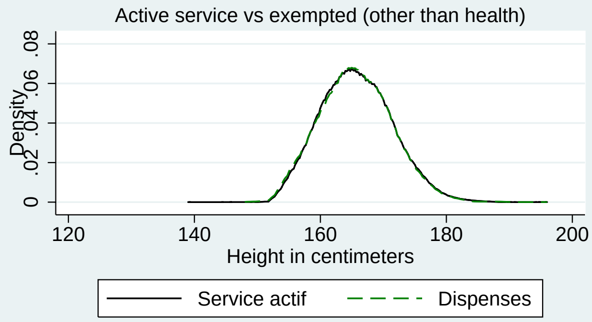
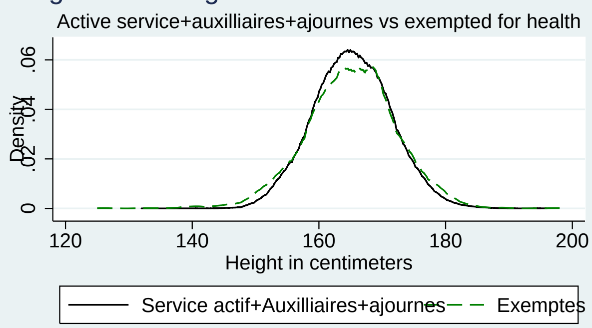


Figure A2: Height Distribution in Individual Data



Source: Authors' calculation from data reported in Farcy and Faure (2003)

References :

Official publications.

Ministère de l'Agriculture, du Commerce et des Travaux Publics, *Enquête agricole, 2e série, Enquêtes départementales*, Paris, 1867 ; 22e circonscription (Gard, Bouches-du-Rhône) and 23e circonscription(Vaucluse).

Ministère de l'Agriculture et du commerce, *Récoltes des céréales et des pommes de terre de 1815 à 1876*, Paris, Imprimerie Nationale, 1878.

Ministère de la guerre Compte rendu sur le recrutement de l'armée, yearly 1872-1912

Statistique de la France : 2e série, t. III IV X XI and then yearly *Mouvement de la Population*. (Paris, 1853--).

Statistique de la France : 2e série, t. VII and VIII. *Statistique agricole. Enquête agricole de 1852*, 2 vol. (Paris, 1858-60).

Statistique de la France : 2e série, t. XIX. *Résultats généraux de l'enquête décennale de 1862* (Strasbourg, 1868).

Statistique de la France: Resultats généraux du dénombrement de 1876. Paris, imprimerie nationale, 1878

Statistique Agricole de la France, (Algérie et colonies) publiée par le ministre de l'agriculture. *Résultats généraux de l'enquête décennale de 1882* (Nancy, 1887).

Statistique Générale de la France, *Annuaire Statistique*, Paris, Imprimerie Nationale, 1878--.

Statistique Générale de la France, *Annuaire Statistique*, 1932, Paris, Imprimerie Nationale, 1933.

Works Cited

Almond, Douglas (2006) "Is the 1918 Influenza Pandemic Over? Long-term Effects of In-utero Influenza Exposure in the Post-1940 U.S. Population" *Journal of Political Economy*, 114 (August) 612-712.

Almond, Douglas and Kenneth and Chay (2005) "The Long-Run and Intergenerational Impact of Poor Infant Health: Evidence from Cohorts Born During the Civil Rights Era" MIMEO, Columbia University.

Almond, Douglas and Lena Edlund and Hongbin Li and Jushen Zhang (2006) "Long Term Effects of the 1959-1961 China Famine: Mainland China and Hong Kong" MIMEO Columbia, 2006.

Aron, J. P., Dumont, P. and Le Roy Ladurie, E. (1972) *Anthropologie du conscrit français d'après les comptes numériques et sommaires du recrutement de l'armée 1819-1826*, *La Haye, Mouton,* 1972.

Barker, D.J.P (1992). "Fetal and Infant origins of Later Life disease" London, London: British medical Journal.

Barker, D. J. P (1994). *Mothers, Babies and Disease in Later Life*, London, London: BMJ Publishing Group.

Bertrand, Marianne, Esther Duflo and Sendhil Mullainathan (2004) "How much can we trust differences in differences Estimates" Quarterly *Journal of Economics,* volume 119, number 1, pp 249-275.

Berhman Jere, and Mark Rosenzweig "The returns to birth weight" *Review of Economics and Statistics* volume 86, pp 586-601

Bonneuil, Noël, *Transformation of the French Demographic Landscape, 1806-1906*, Oxford, Clarendon Press, 1997.

Case, Anne and Christina Paxson (2006) "Stature and status: Height, ability, and labor market outcomes", Working Paper, RPDS, Princeton

Chay, Kenneth and Michael Greenstone (2003) "The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in Pollution Shocks Induced by a Recession," (with Kenneth Chay). *Quarterly Journal of Economics*, number 118, volume 3.

Cutler, David Angus Deaton and Adriana LLeras-Muney "The Determinants of Mortality," joint with David Cutler and Angus Deaton, Journal of Economic Perspectives, Vol 20, Number 3, Summer 2006.

Doblhammer (2003) “The Late Life Legacy of very early life” MPIDR Working Paper WP-2003-030.

Duflo Esther (2003) “Grandmothers and Granddaughters: Old Age Pension and Intra-household Allocation in South Africa,” *World Bank Economic Review* 17(1) , pp. 1-25.

Farcy, Jean-Claude et Faure, Alain (2003), Une génération de français à l'épreuve de la mobilité. Vers et dans Paris : recherche sur la mobilité des individus à la fin du XIXe siècle. Paris, INED.

Fogel, R. W. *The Escape from Hunger and Premature Death, 1700-2100,* Cambridge: Cambridge University Press, 2004.

Galet, Pierre, *Cépages et vignobles de France*, Montpellier, 1957-1962.

Goubert, Jean-Pierre. *The Conquest of Water: The Advent of Health in the Industrial Age.* Princeton: Princeton University Press, 1989.

Heyberger, L. *La révolution des corps,* Strasbourg, Presses Universitaires de Strasbourg, 2005.

Jensen, Robert (2000) “Agricultural Volatility and Investments in Children” American Econmic Review, Papers and Proceedings, volume 90, number 2, pp. 399-405.

Meng, Xin and Nancy Qian “The Long Run Health and Economic Consequences of Famine on Survivors: Evidence from China's Great Famine”, Working Paper, Brown University.

Postel-Vinay, Gilles, “ Debts and Agricultural Performance in the Languedocian Vineyard, 1870-1914” In Grantham, G. and Leonard, C. S. (Eds.), *Agrarian Organization in the Century of Industrialization : Europe, Russia, and North America* (Greenwich, Connecticut and London, 1989), pp. 161-186.

Postel-Vinay, Gilles, and Sahn, David, “ Explaining Stuting in nineteenth Century France”, LEA Working Paper, INRA, 2006.

Ordish, George. *The Great Wine Blight*, New York: Charles Scribner's Sons, 1972.

Ravelli ACJ, van der Meulan JHP, Michels RPJ, Osmond C, Barker DJP, Hales CN, Bleker OP. 'Glucose tolerance in adults after prenatal exposure to the Dutch famine'. *International Journal of Epidemiology* 2002, vol. 31, pgs 1235-1239,

Roseboom TJ, van der Meulen JHP, Michels RPJ, Osmond C, Barker DJP, Hales CN, Bleker OP. 'Adult survival after prenatal exposure to the Dutch famine 1944-45' Pediatric and Perinatal Epidemiology 2001, vol. 15, pgs 220-225.

Steckel, Richard H. "A Peculiar Population: The Nutrition, Health, and Mortality of American Slaves from Childhood to Maturity." *Journal of Economic History*, September 1986, 46(3) 721-741.

Steckel, Richard H. "Stature and the Standard of Living." *Journal of Economic Literature*, December 1995, 33(4) 1903-1940.

Steckel, Richard and Roderick Floud (1997), *Health and Welfare during Industrialization,* NBER, Chicago and London, The University of Chicago Press.

Strauss, John and Duncan Thomas (1995) "Human Resources: Empirical Modeling of Household and Family Decisions" in Berhrman, Jere and T.N. Srinivasan ed.s *Handbook of Development Economics*, Amsterdam: North Hollandchapter 34, pages 1885-2023.

Van Meerten, M. A. "Développement économique et stature en France, XIXe-Xxe siècles", *Annales, Economie, Sociéte, Civilisation.* 45 (1990), pp. 755-78.

Van den Berg, Gerard J., Martin Lindeboom, and France Portrait (2006), "Economic Conditions in Life and Individual Mortality", *American Economic Review*, Vol. 96, n° 1, p. 290-302.

Weir, D. "Economic Welfare and Physical Well-Being in France, 1750-1990", in Steckel, R. H. and R.Floud (eds), *Health and Welfare during Industrialization*, (Chicago, 1997), pp. 161-200.

Woloch, Isser (1994). The New Regime; Transformation of the French Civic Order, 1789-1820s. New York. Norton.