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STEALING TO SURVIVE? CRIME AND INCOME SHOCKS IN NINETEENTH CENTURY FRANCE*

Vincent Bignon, Eve Caroli and Roberto Galbiati

Using local administrative data from 1826 to 1936, we document the evolution of crime rates in nineteenth century France and we estimate the impact of a negative income shock on crime. Our identification strategy exploits the phylloxera crisis. Between 1863 and 1890, phylloxera destroyed about 40% of French vineyards. We use the geographical variation in the timing of this shock to identify its impact on property and violent crime rates, as well as minor offences. Our estimates suggest that the phylloxera crisis caused a substantial increase in property crime rates and a significant decrease in violent crimes.

Economic theory and casual observation both suggest that economic crises may favour criminal activity as they alter the opportunity costs of engaging in crime. At the same time, higher crime rates are likely to have a negative impact on economic conditions as the prevalence of crime in an area discourages business. Thus, negative income shocks may trigger a vicious circle between deteriorating economic conditions and crime. Although this relation seems to be quite intuitive, it is far from easy to document due to standard endogeneity problems. In order to single out the causal impact of negative shocks to the economy on crime rates, ideally we would like to observe a comparable set of countries or administrative units within a country over a long period of time and we would like to treat randomly some of them inducing negative economic shocks. On top of such an ideal experiment we would like to have reliable data on crime rates with both time and spatial variation. In this article, we claim that nineteenth century France provides such an ideal setting.

To identify the impact of a negative economic shock on crime, we take advantage of the phylloxera crisis that burst in France in the second half of the nineteenth century. The phylloxera (an aphid which attacks vines' roots) destroyed about 40% of vines in France, thus inducing a large productivity shock in an economy still largely dependent on agricultural production.[1] According to historical research, this turned into a major income shock for a number of reasons. First, the decrease in wine production was not

* Corresponding author: Vincent Bignon, Banque de France DGEI–DEMFI–Pomone (041-1422); 31, rue Croix des Petits Champs, 75049 Paris Cedex 01 France. Email: vincent.bignon@banque-france.fr.

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[1] Wine represented on average 17% of agricultural production.

matched, by far, by an equivalent increase in wine prices. Second, the reduction in wine-generated income did not trigger a substantial substitution of wine for other agricultural products. Eventually, in some *départements*,[2] the crisis was so strong as to induce a partial collapse of the local credit system (Postel-Vinay, 1989), thus preventing any smoothing of the crisis. In the absence of a welfare state, a large share of the population suffered a major income drop.

The phylloxera crisis started in 1863 when the aphid first appeared in Southern France and ended in the 1890s when vineyards were replanted with hybrid American vines which were resistant to the insect. As phylloxera affected the different *départements* in different years, we exploit the spatial variation in the timing of the shock to identify its effect on crime rates. The massive negative shock to the French economy induced by the phylloxera attack is indeed an ideal natural experiment that helps in solving the major identification problems related to reverse causality and confounding factors. To the best of our knowledge, the only article exploiting the source of exogenous variation in income induced by the phylloxera epidemic is Banerjee *et al.* (2010) who show that children who were *in utero* in families involved in wine production in years where their region was affected by phylloxera ended up being significantly shorter at 20 years old than children conceived either before or after phylloxera.

Our analysis uses uniquely rich data on criminal records collected between 1826 and 1936 by the French Ministry of Justice at the *département* level. These data represent, to the best of our knowledge, the oldest national official administrative crime record exploited by researchers up to today. They allow us to identify the impact of the crisis triggered by the phylloxera epidemic on violent and property crimes, as well as on minor offences. This exercise is unique from a historical perspective since comparable data sets were collected only starting in the twentieth century in other countries (e.g. the Uniform crime report in the US starts being compiled in the 1930s) or for a shorter period of time in some German states such as Bavaria and Prussia (Mehlum *et al.*, 2006; Traxler and Burhop, 2010). Our results show that the phylloxera crisis caused a strong increase in property crimes and a significant decrease in violent crimes.

This article contributes to the literature on the effects of negative economic shocks on crime in an historical perspective by covering more than 80 French *départements* over 1826–1936 (see online Appendix B.). It is one of the very first exercises of this kind in economic history. To the best of our knowledge, only a couple of papers resort to historical data to study the impact of changing economic conditions on crime. Mehlum *et al.* (2006) estimate the impact of an increase in poverty on crime in nineteenth century Bavaria. The authors use rainfall as an instrumental variable for rye prices and show that an increase in rye prices following bad weather conditions induces an increase in property crimes and leads to significantly fewer violent crimes. Traxler and Burhop (2010) replicate this exercise for Prussia and find similar results. With respect to Mehlum *et al.* (2006), it is worth noting that, although we cover a similar historical period, our research design has a number of advantages. We have observations for both our independent and dependent variables for each of the 87 French *départements* over the whole period of analysis. In contrast, Mehlum *et al.* (2006) use data on crime rates in

[2] The *départements* are geographical and administrative units roughly equal in size to a US county.

seven Bavarian regions while they only have one single series of rainfall and rye price data for the whole of Bavaria. Moreover, while rainfall potentially affects both economic conditions and the probability of apprehension of criminals – since the cost of searching for criminals may be higher if weather conditions are bad – the phylloxera crisis affects incomes but is unlikely to have altered the cost of crime fighting and hence the probability of apprehension.

A few papers in the literature exploit, as we do, natural experiments to analyse the impact of a negative income shock on criminal activity in today's economies. Miguel (2005) uses survey data on contemporary rural Tanzania to show that the killing of 'witches' (i.e. old women) increases in times of extreme weather events leading to floods and droughts. Fafchamps and Minten (2006) exploit an exogenous cut in fuel supply in rural Madagascar following a disputed presidential election to identify the effects of a massive increase in poverty and transport costs. Using original survey data collected in 2002, they find that crop thefts increase at times of rising poverty.

Our study also relates to the literature on the effects of the business cycle on crime, since the phylloxera crisis constituted a strong negative shock to the French economy. Consistent with our findings, this literature finds that trends in property crimes in the USA and France are countercyclical (Cook and Zarkin, 1985; Lagrange, 2003).

A recent literature on unemployment and crime finds results consistent with our main findings. These studies using panel data at the state or regional level (Raphael and Winter-Ebmer, 2001; Gould *et al.*, 2002; Oster and Agell, 2007; Buonanno and Montolio, 2008; Lin, 2008; Fougère *et al.*, 2009; Mocan and Bali, 2010)[3] reach a consensus that increasing unemployment contributes to raising property crimes (although the magnitude is not large).

The article develops as follows. Section 1 provides some background information about the phylloxera pest and a conceptual framework. Section 2 presents the data sources and the main trends in crime rates in nineteenth century France. Section 3 describes the time pattern of the effects of phylloxera and justifies the choice of our phylloxera indicator. Section 4 presents the results of regression analyses and Section 5 provides some conclusions.

1. Historical and Theoretical Background

1.1. *Phylloxera and Income Shock*

At the beginning of the nineteenth century, the French economy was still very dependent on agriculture that represented a major source of income for many households. The share of agricultural production and extractive industry in GDP amounted to 38.5% in 1830, decreased to 33% in 1850 and was still as high as 28% in 1890 (Craft, 1984, p. 54). This made France much more dependent on agriculture than the UK, for example where the corresponding shares were respectively 24.9% in 1840 and 13.4% in 1890 (Craft, 1984, p. 53). Wine production represented a large part of the value of agricultural production. In 1862, the year

[3] A complete survey of this literature goes beyond the scope of this study. Recent interesting surveys discussing results in criminology, public policy and economics are Paternoster and Bushway (2001) and Bushway (2011).

before phylloxera was first spotted in France, wine production amounted to about one-sixth of the value of agricultural production thus representing the second most important product after wheat. Any disease affecting French vineyards was therefore likely to represent a major shock to a mostly rural economy. Phylloxera turned out to be such a shock.

'Phylloxera vastatrix' is a near-microscopic aphid that hangs on the roots of vines and sucks the sap. It originally lived in North America and did not reach Europe in the era of sailing ships since the journey took so long that upon arrival either the vine cuttings or the aphid on them had died. Steam power provided the greater speed necessary for the insect to survive the journey. Although it was harmless to grape vines in its original ecology, it proved a devastator to European species, causing their death in a very short while (Simpson, 2011, p. 36). French vineyards started to be affected in 1863 but it was not before 1868 that scientists identified its presence on dead roots in the Gard *département*. Until 1875, there was a fierce scientific debate as to the responsibility of phylloxera in vines death. Some scientists argued that it was the cause of the death, whereas most of them claimed that it was a consequence of it: vines were dying because wine growers would not take good care of them and phylloxera was developing on dead vines (Pouget, 1990; Gale, 2011).

The insect progressively expanded across *départements* although this expansion was initially quite slow (Garrier 1989, ch. 3) – see Figure 1 for the time pattern of the diffusion of phylloxera. By the middle of the 1870s, the aphid affected most *départements* in the Southeast of the country (Bouches du Rhône) and in the Bordeaux region. Its spreading pattern was very difficult to predict since phylloxera spread either because it was carried by the wind or because it was hanging on an object or a plant which was carried around by human activity, including on long distances. Other factors also played a role. For example, its expansion in the Charente *département* was described as 'nearly explosive' and greatly favoured by the heat and drought of 1875 (Gale, 2011, p. 152) So, even after 1875 when the origin of the pest was identified, farmers kept being surprised by its arrival in their area and sometimes denied it on the grounds that they were taking good care of their vines; see Ordish (1972, p. 134) and Loubère (1978, ch. 4).

During that period, experts experimented with various treatments to fight against the pest from vineyard flooding to the use of chemical products. None of the treatments introduced proved to be effective until a botanist named Alexis Millardet showed in 1882 that vines could be made resistant to phylloxera by grafting European vines onto phylloxera-resistant American roots. It then took several years before people understood how to implement the grafting in order to produce drinkable wine. This was because not all types of US roots were suitable for the various types of French soils and wine species. In 1888, Pierre Viala came back from America having identified 431 types of American vines and selected those likely to be successfully grafted in France. This opened the way to the recovery which started in the early 1890s (Paul, 1996, p. 113ff; Gale, 2011, ch. 4).

As it contaminated *départements*, phylloxera caused a huge decrease in wine production. According to our estimates – see subsection 4.1 – on average, full contagion of a *département* by phylloxera brought about a 35% reduction in wine

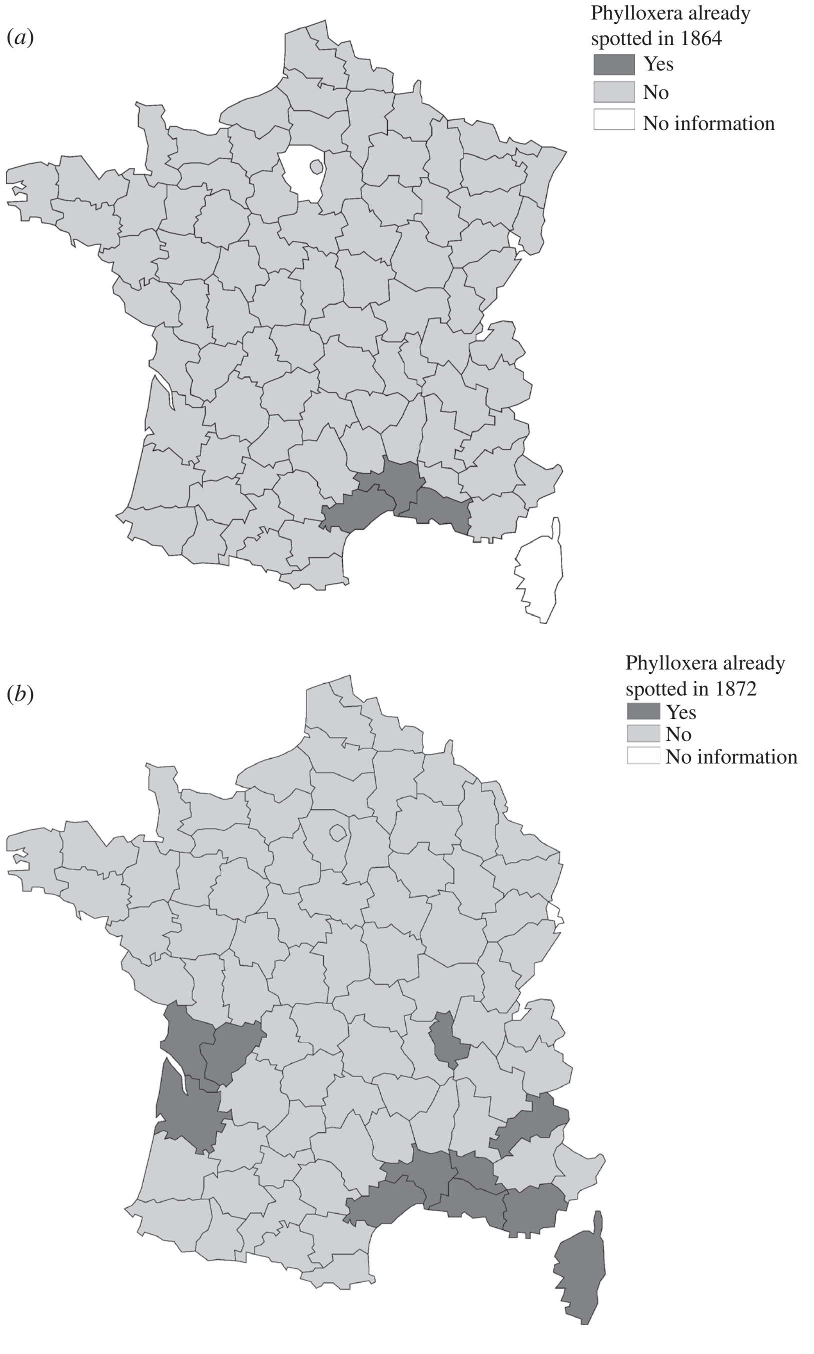

Fig. 1. *The Diffusion of Phylloxera*

production. As reported by Loubère (1978, p. 157), ‘there was no measure of the despair the southern vintner felt as he watched helplessly, obstinately unbelieving, while his vines faded and died’.

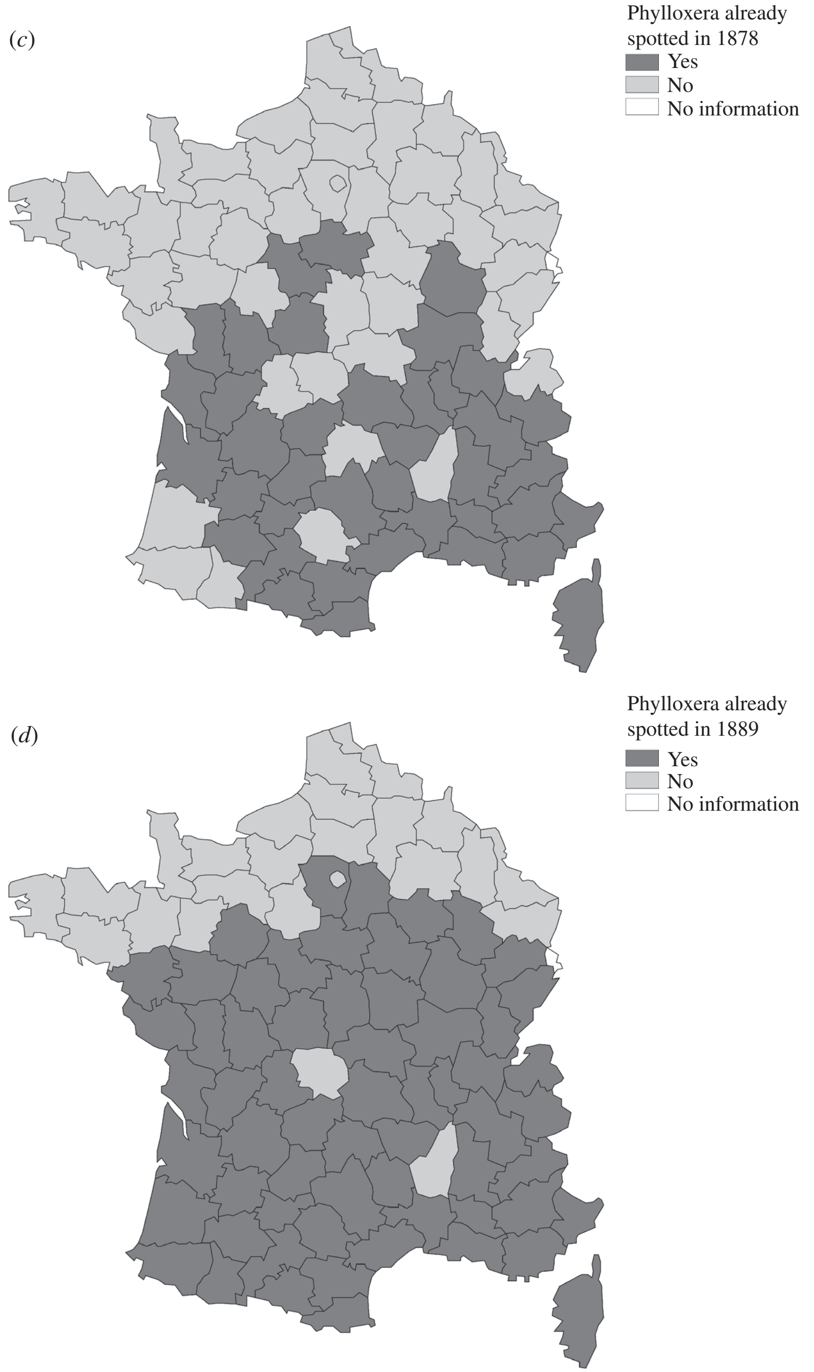

Fig. 1. *(Continued)*

The sharp decline in wine production was not compensated by an equally strong increase in wine prices. In order to compensate for the decrease in the supply of French wine, French authorities relaxed both wine import rules and quality standards. Wine growers were allowed to sell '*piquettes*' or '*second or third wine*' – made by mixing press cakes with water, pressing it, adding sugar to the run and fermenting. They were also allowed to produce raisin wines, a beverage made out by soaking imported dried raisins and drawing off the liquid until the exhaustion of all of its sugar (Loubère, 1978, p. 166). According to Ordish (1972, tables 9–11), the sum of imports, *piquettes* and raisin wine represented 58.6% of domestic wine production in 1889, and 61.5% in 1890 as compared to less than 0.5% in the 1860s.[4] This large inflow of imports and wine substitutes together with the decrease in average wine quality kept the price of wine from increasing at the same pace as the decline in French production (Ordish, 1972; figure 2 in Banerjee *et al.*, 2010).

So, the spread of phylloxera generated a major income shock. Contemporary estimates made by A. Lalande suggest that phylloxera cost France twice as much as the war indemnity paid to the Germans in 1870 which amounted to 25% of one-year GDP (Ordish, 1972; Occhino *et al.*, 2008). More recently, Pierre Galet estimated that the cost could have been as high as 15 billion francs, that is three times the war indemnity (cited in Simpson, 2011, p. 36). The share of the value of wine production in GDP indeed went down from 6.84% in 1862 to 2.71% in 1890, while the share of *départements* affected by phylloxera increased from 0% to 71.3% – see Figure 2.

This decrease in wine-generated income did not trigger a substantial shift towards other agricultural products. The area planted with vines did not significantly decrease subsequent to the arrival of phylloxera (Banerjee *et al.*, 2010). Most areas planted with vines were indeed ill suited to other crops. Moreover, wine growers were reluctant to switch from a high value-added product to less lucrative crops, such as wheat, for example (Loubère, 1978, p. 167). Most of them expected some cure to be found in the near future. Ordish (1972, p. 155) even argues that 'there was a mystique attached to wine growing felt by the majority of small growers who found it difficult to envisage any other way of life'.

Given the size of the income shock in wine-producing *départements*, the credit system itself partly collapsed thus preventing farmers from relying on borrowing to smooth out the crisis (Postel-Vinay, 1989). Central and local governments would not provide any financial help to compensate for the loss of income. Moreover, the only institutions in charge of poor relief, the so-called *bureaux de bienfaisance*, were charities organised on a local community basis which found themselves in great difficulty because of the crisis. The British consul at Bordeaux noticed in 1886 that 'the number, more especially of the smaller class of proprietors on Medoc, in Sauterne and other *département*s of the Gironde who have been utterly ruined is

[4] Imports jumped from 0.2 million hectolitres in the 1860s to 10 million in the 1880s. They represented 0.3% of domestic wine production in 1862 as compared to 40% in 1890. Assessing the volume of *piquettes* precisely is more difficult. A lower bound can be estimated using the volume of sugar mixed with press cakes. This has been recorded because this sugar used to be subsidised by the State. Ordish (1972) suggests that *piquettes* could have amounted to 11% of regular wine production. As far as raisin wine is concerned, it represented at most 11% of domestic wine production over the period.

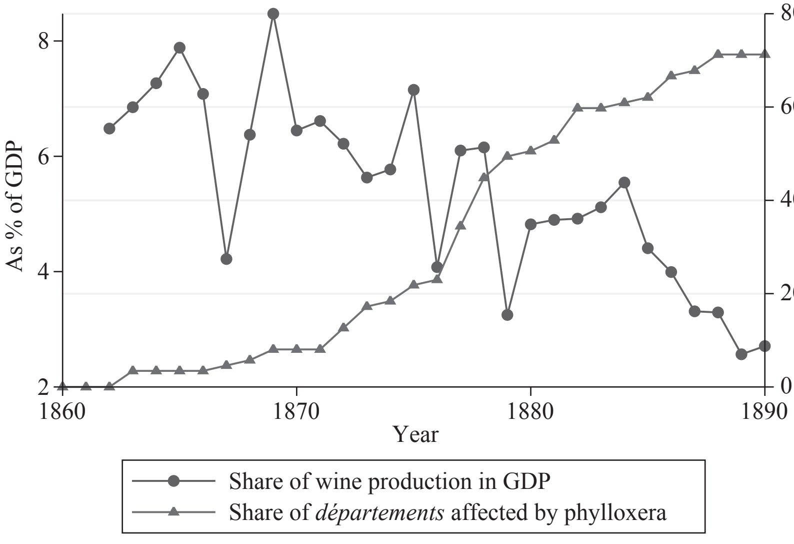

Fig. 2. *Phylloxera and Share of Wine Production in GDP, 1862–90*
Source. Authors' computations from *Annuaire Statistique de la France* (1946), Galet (1957), Toutain (1987) and Maddison (1995).

considerable' (cited in Ordish, 1972, p. 146). Similarly, Arambourou (1958, p. 374) summarises: 'For many peasants, ruin was complete; for all of them the financial difficulty was considerable'.

1.2. *Conceptual Framework*: *Income Shock and Crime*

In the rest of the article, we provide estimates of how the phylloxera epidemic affected crime rates in the second half of the nineteenth century in France. Before moving to the empirical results it is worth discussing mechanisms through which the negative income shock triggered by the diffusion of phylloxera may have affected crime rates. The more general, underlying question is: how do economic crises and local negative income shocks affect individuals' choices with respect to criminal activity? Property crimes and violent crimes may respond to different factors which we discuss separately in the following.

According to the standard economic model of crime (Becker, 1968), individuals choose between criminal and legal activities on the basis of the expected utility of each. In this simple framework, returns to legal activity are determined by market earnings (wages for salaried workers and profits for the self-employed), whereas returns to illegal activity depend on the potential pay-off of crime and the expected sanctions imposed by the criminal justice system. Expected sanctions are an increasing function of the probability of getting caught and of legal punishment if caught. Individuals will choose to engage in criminal activities (or increase their involvement at the margin) if the expected return to criminal activity outweighs the expected return to legal activities; see Ehrlich (1973) and Cook *et al.* (2013). This simple framework is helpful to pin down the potential effects of the economic crisis triggered by the phylloxera epidemic.

The drop in income caused by the contraction of wine production may have affected individual decisions regarding property crimes through different channels. First, it is likely to have reduced the expected return to legal activities either because of an increase in the probability of being unemployed and/or via a reduction in wages for employees working in the wine industry and/or because of the decrease in wine-based revenues for self-employed wine growers. If unemployment increased during the economic crisis triggered by phylloxera, the model proposed by Raphael and Winter-Ebmer (2001) suggests that the time allocation of individuals is likely to have been modified in favour of income-generating criminal activities. The model predicts criminal behaviour as a function of potential earnings on the legal labour market relative to the returns to property crimes and preferences over income and non-market time. In this framework, unemployment increases the time devoted to criminal activities for those who already engaged in property crime while working in the legal labour market. For workers who did not engage in crime before being unemployed, whether or not they should commit property crimes as a result of unemployment depends on whether the return to one hour spent in criminal activities exceeds their reservation wage. Individuals with high reservation wages are unlikely to commit property crimes as a result of an unemployment spell. In contrast, individuals with low reservation wages are more likely to reallocate time towards property crime in order to compensate for the loss of income due to unemployment.[5] Raphael and Winter-Ebmer (2001) find that an increase in unemployment raises property crimes both at the intensive and extensive margins. Evidence from contemporary data suggests that property crime rates also respond to decreases in unskilled workers' wages since they reduce the expected return on legal activities (Machin and Meghir, 2004). Based on these theoretical considerations, we expect the strong negative income shock triggered by phylloxera to have increased the relative incentives to commit property crimes as compared to engaging in legal income-generating activities. Beyond affecting the expected return to legal activities, phylloxera also reduced the quality and quantity of wine production potentially targeted by criminals. More generally, it is likely to have lowered the quality and quantity of other sources of illegal incomes, thereby reducing the expected pay-off from property crimes. So, the economic downturn generated by the spread of phylloxera has modified the relative gains from legal *versus* illegal income-generating activities in a potentially ambiguous way. Moreover,

[5] Criminologists – see, for example Cantor and Land (1985, 1991) – have argued that things may go the other way round so that high unemployment during economic downturns may result in a reduction in crime rates. Based on the 'routine activities' theory the argument goes as follows: immediately after losing their job, the unemployed are less likely to visit public places where the risk of being victimised is greater and they are more likely to spend time guarding their homes thus reducing the risk that they be burgled. Recent empirical evidence reporting a positive relationship between unemployment and crime suggests that other forces such as the reduction in the opportunity cost of engaging in income-generating criminal activities tend to compensate the potential reallocation of time in favour of home-based activities. A detailed discussion of these aspects can be found in Paternoster and Bushway (2001).

the decision to engage in criminal activity does not only depend on the relative gains from criminal *versus* non-criminal activities. It also depends on the probability of apprehension and on the severity of court sentences. Both may also have been affected by the income shock generated by phylloxera. In particular, local tax revenues may have decreased following the fall in income, triggering a reduction in the number of police forces and/or in their endowments. This may, in turn, have reduced the probability of apprehending criminals.[6] The severity of court sentences may also have decreased if judges became more lenient because they were conscious that making a living out of legal income opportunities had become more difficult.[7]

All in all, the potential effect of negative income shocks in general, and of the phylloxera crisis in particular, on property crime rates is theoretically ambiguous. In the rest of the article, we describe and estimate the effects of the income shock triggered by the diffusion of phylloxera taking into account the potential existence of different channels of impact. Our historical data do not allow us to quantify the effect of each channel separately but the sign of the point estimates on the phylloxera variable in our regressions allows us to determine whether the negative effect of the income shock on legitimate labour income opportunities outweighs the potential negative effects of the economic downturn on illegal market income and on expected sanctions. In order to make sure that changes in expected sanctions are not the main driver of our results, we control in some specifications for the local presence of police forces and we check that phylloxera did not significantly affect conviction rates.

As regards the effect of the phylloxera epidemic on violent crimes, theoretical predictions are clearer. To the extent that alcohol is a normal good, as local income decreased, alcohol consumption is likely to have decreased too. There is evidence in the contemporary literature that alcohol consumption has criminogenic effects in today's economies (Cook and Moore, 1993; Carpenter and Dobkin, 2011). If this was already the case in nineteenth century France, as alcohol consumption went down following phylloxera, violent crimes should have decreased as well. However, the impact of drinking on crime is likely to depend on consumption habits and social norms which may vary over time – see Felson *et al.* (2011). It is thus worth considering what criminologists and other social scientists thought at that time. In the second half of the nineteenth century, an important literature underlined the key role of alcohol consumption in generating violent crimes in France. Emile Levasseur, a professor of geography at Collège de France, wrote, for example,

> A lot of wine, a lot of drunkards; as a consequence many violent acts, assaults and battery. M. Lacassagne provided evidence of this relation by comparing the evolution of some crimes with that of wine production. He even sees a relation between the number of violent crimes and election years such as 1865

[6] In the specific context of nineteenth century France, this effect should be less of a concern however. The number and availability of police forces were indeed mainly determined at the national level so that it was not very sensitive to local economic conditions.

[7] Ichino *et al.* (2003), for instance, show that Italian labour judges are more likely to decide in favour of workers whenever local unemployment is higher.

> and 1876 in which taverns have got more clients than usual and he adds that the same thing has been noticed in England.
>
> (Levasseur, 1891, p. 442).[8]

Similar accounts of how alcohol consumption affects violence and hence criminality are provided by criminologists (Lombroso, 1887; Tarde, 1903; Yvernès, 1912), medical scholars (Jolly, 1865) and even engineers (Jacquet, 1912). Following this literature, if the phylloxera epidemic lowered wine consumption, it is likely to have reduced violent crimes too. We show in Section 4 that this is actually what happened. In the discussion of our results, we also provide evidence that alcohol consumption and violent crimes are positively associated at the national level.

2. Data

2.1 *Crime and Police Forces*

Since the very beginning of the nineteenth century, the French judicial system was highly centralised. France was a Roman-law country where the Napoleonic codes were the basis of criminal and civil law (Carbasse, 2000). Starting in 1826, the French Ministry of Justice published a statistical yearbook entitled the *Compte Général de la Justice Criminelle*. It was based on reporting by local court public prosecutors and clerks. We hand-collected data from this source.

The *Compte Général* was one of the most continuous and reliable sources in France at that time (Lodhi and Tilly, 1973, pp. 299–300). It has been used as a model for setting up criminal statistical records in several countries (Perrot and Robert, 1989). Since its first publication, the *Compte* was assigned a double role. It was a management tool that was designed to help the government assess the working of the law and the effects of legal reforms. But, beyond policy makers, it was also supposed to provide information to moralists and thinkers. As such, it contributed to the birth of criminology. Although the *Compte* was published yearly until 1982, we only collected data for the period from 1826 to 1936. As underlined by Perrot and Robert (1989) the quality of the data indeed declined after the 1930s, in particular due to the decrease in the funding awarded to the judiciary system for collecting statistical information.

The *Compte* provides detailed information on the number of people charged and acquitted of violent crimes, property crimes and minor offences in each *département* every year (see Figure 3 for crimes – a similar table is available for minor offences). Violent crimes include homicides, sexual assaults, injuries, violence against children, abortion, plotting, rebellion and false witnesses. Property crimes encompass thefts, robberies, counterfeiting, corruption, destruction, fires and pillaging. Minor offences include a large range of offences considered as less serious than crimes and judged by magistrates' courts rather than by people's juries as is the case for crimes. They include damages to public monuments, threats, involuntary homicides or wounds, minor thefts, harvest destruction, illegal practice of birth giving etc. Information about

[8] Translated from French by the authors.

COURS D'APPEL.	DÉPARTEMENTS.	CRIMES										NOMBRE TOTAL				
		CONTRE LES PERSONNES. — NOMBRE					CONTRE LES PROPRIÉTÉS. — NOMBRE									
					des condamnés à des peines					des condamnés à des peines					des condamnés à des peines	
		des accusations.	des accusés.	des acquittés.	afflictives et infamantes.	correctionnelles.	des accusations.	des accusés.	des acquittés.	afflictives et infamantes.	correctionnelles.	des accusations.	des accusés.	des acquittés.	afflictives et infamantes.	correctionnelles.
AGEN	Gers	21	30	12	10	8	12	12	3	3	6	33	42	15	13	14
	Lot	4	7	3	3	1	8	8	1	1	6	12	15	4	4	7
	Lot-et-Garonne	6	6	2	1	3	22	34	3	11	20	28	40	5	12	23
AIX	Alpes (Basses-)	10	12	»	5	7	6	6	1	2	3	16	18	1	7	10
	Alpes-Maritimes	21	27	11	6	10	13	25	6	7	12	34	52	17	13	22
	Bouches-du-Rhône	27	34	7	12	15	43	92	25	36	31	70	126	32	48	46
	Var	14	15	3	8	4	21	25	5	12	8	35	40	8	20	12
AMIENS	Aisne	32	33	8	11	14	23	26	7	9	10	55	59	15	20	24
	Oise	33	38	8	20	10	33	39	8	17	14	66	77	16	37	24
	Somme	26	33	9	19	5	33	36	6	21	9	59	69	15	40	14
ANGERS	Maine-et-Loire	15	15	1	9	5	19	22	2	10	10	34	37	3	19	15
	Mayenne	5	6	4	»	2	12	14	1	7	6	17	20	5	7	8
	Sarthe	11	13	3	6	4	16	21	4	7	10	27	34	7	13	14

Fig. 3. *Compte Général de la Justice Criminelle, 1869*

detailed crime and offence categories is not available at the *département* level. Nonetheless, the *Compte* provides data on the number of people accused of a number of more precisely defined crimes such as: homicides, thefts in churches, on country roads, domestic thefts and other thefts for a more limited period of time.[9] Using the population provided by the Census[10] for each *département*, we compute yearly crime rates defined as the ratio of the number of people accused to the population, broken down by type of crimes and offences, in each *département*. Given the poor quality of population data during war years, we drop years 1870–1 and 1914–8 from our sample (see online Appendix B.1). Overall, the largest sample for which we have information for either property or violent crimes or minor offences contains 8,847 observations over the period 1826–1936. For other crime categories, sample size varies across category from 8,847 (1826–1936) to 7,208 (1826–1912) (see online Appendix B.3).

Figures 4 and 5 report crime rates aggregated at the national level for the period 1826–1936. We also compute conviction rates for each type of crime and offence by dividing the number of people convicted by the number of people accused in each *département* every year. The corresponding rates vary from 64% for violent crimes to 72% for property crimes and 91% for minor offences (see online Appendix Table A1).

Finally, the *Compte* also provides information on police forces. More precisely, we know the yearly number of urban and rural policemen, superintendents, forest wardens and guardsmen in each court-of-appeal jurisdiction between 1843 and 1932.[11] We compute an indicator of the presence of police forces defined as the ratio of the

[9] Homicides and all thefts are available over the entire period, while thefts on country roads, domestic thefts and other thefts are available for 1826–1923 and thefts in churches for 1826–1912 only.

[10] Census data are available every five years only. In order to get yearly data for population at the *département* level, we interpolate Census data using growth rates of population between Census years (see online Appendix B).

[11] See Gillis (1989, pp. 315–6) for a presentation of the different types of police forces. In the *Compte*, the data are actually available at the court (i.e. infra-*département*) level for 1843–62, at the *département* level for 1879–85 and at the court-of-appeal level for 1863–78 and 1886–1932. We aggregate them at the court-of-appeal level for all years between 1843 and 1932. There were 27 courts of appeal in France in 1826.

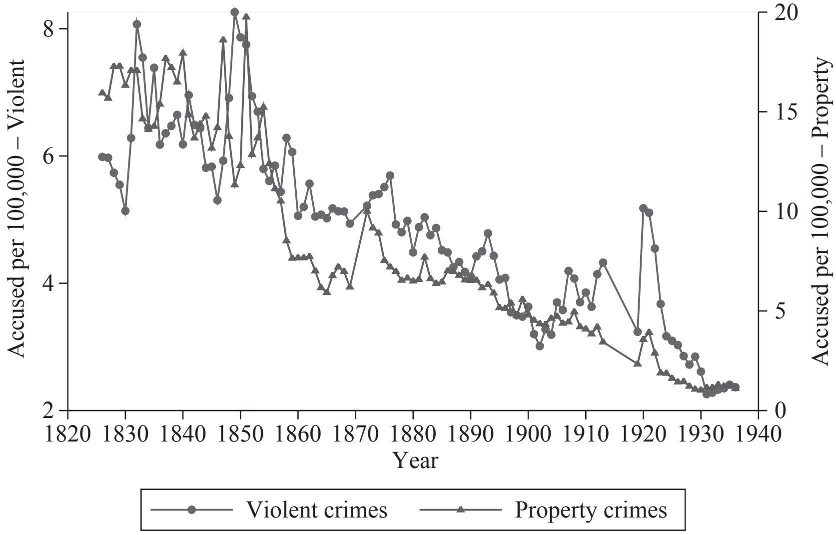

Fig. 4. *Violent and Property Crimes in France 1826–1936*

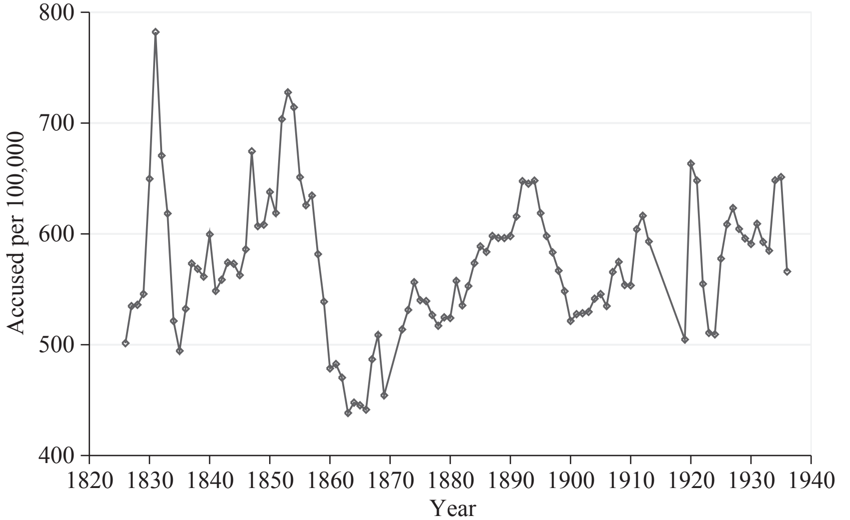

Fig. 5. *Minor Offences in France 1826–1936*

total number of police forces divided by the population in each court-of-appeal jurisdiction. Over the period we study, there were on average three members of police forces for 1,000 inhabitants in France (see online Appendix Table A1).

2.2. *Phylloxera, Wine Production and Wine Intensity*

We collected data on the presence of phylloxera starting from information provided in Galet (1957). The book reports both the year when phylloxera was first spotted in at least one municipality of each *département* and the year when the *département* was fully contaminated (i.e. all municipalities of the *département* were affected).[12] Phylloxera had been spotted in 3.3% of the 87 French *départements* in 1865, whereas this figure amounted to 50.5% in 1880 and 71.3% in 1890 (see also Figure 1). The first *département* to be totally affected by phylloxera was Vaucluse in 1875. This was the case of 17% of all *départements* in 1880.

Data on wine production are also drawn from Galet (1957). In our data set, the number of hectolitres of wine produced is available for all *départements* between 1850 and 1905. Wine was produced in 79 out of the 87 French *départements* in 1862 – that is the year before phylloxera was first spotted in France.

Using information provided by the 1862 Agriculture Survey, we compute a measure of wine intensity in the various *départements* before phylloxera was first spotted in France. We compute the share of wine in agricultural production as of 1862: it is larger than 15% in 39 *départements*. We also use data on the surface planted in vines per inhabitant in 1862: the French average is as high as 0.07 ha (see online Appendix Table A1). Using the 1861 census we also compute the share of people employed in agriculture at the *départment* level. We use these variables in specifications in which we allow the impact of phylloxera on crime rates to vary according to the importance of wine-related activities in each *département* as of 1862.

2.3 *Socio-economic Characteristics and Urbanisation*

When estimating the average impact of phylloxera on crime rates, we include socio-demographic controls in some specifications. Using the data from the *Statistique Générale de la France* available for 1851–1911, we compute the ratio of males in the *département* population. We also control for the age structure of the male population, that is the ratio of males aged 15–19, 20–29, 30–39 and 40 years old and above. Since these data come from the Census which is available every five years only, we regress a five-year moving average of crime rates on a five-year moving average of our phylloxera indicator and the socio-demographic variables.[13]

We use a similar specification when controlling for urbanisation. The data come from the INED-Urbanisation database and are also available for Census years only.[14] We compute the proportion of people living in towns with more than 2,500 inhabitants – which is the standard definition of a town in France (Pumain and Guérin-Pace, 1990) – and the proportion of people living in the three largest cities in the *département*. We control alternatively for each of these two measures of urbanisation in order to make sure that our results are not due to changes in the urban structure of the French *départements* that would be correlated with the presence of phylloxera. Descriptive statistics of these variables are provided in online Appendix Table A1.

[12] This information is missing for two *départements*: Ardèche and Creuse. So, over the 1826–1936 period, the number of observations for which we have information on phylloxera is 8,639.
[13] The five-year moving averages are computed around census years.
[14] See Pumain and Riandey (1986) for a thorough description of the data.

3. The Time-pattern of the Effects of the Phylloxera Epidemic on Wine Production and Crime Rates

We start our empirical analysis of the effect of the phylloxera crisis by providing some evidence on the time pattern of its impact on wine production and crime rates. In order to provide preliminary evidence on the short and long-run effects of phylloxera, we estimate a fixed-effect model of the form:

$$\log(wp_{dt}) = \alpha_t + \beta_d + \sum_{\tau=0}^{k} \gamma_\tau P_{d\tau} + \varepsilon_{dt}, \tag{1}$$

where d indexes *départements* and t indexes years, wp_{dt} denotes wine production and $P_{d\tau}$ are dummy variables for each cumulative number of years (τ) since phylloxera was first spotted in *département d*. The focus of (1) is on the estimates of the time-varying effects of phylloxera γ_τ. Since this model only considers within-department variations over time, it can be interpreted as the average across-*département* difference in wine production relative to *département* average, when a *département* has been under phylloxera for γ years.

Figure 6 reports the γ_τ co-efficients as a function of the number of years since phylloxera was first spotted in the various French *départements*. It reveals an interesting time pattern. Consistent with historical records and historians' accounts (Garrier, 1989) the pest took some time to spread. On average, the parasite did not significantly affect wine production in the very first years after it was first noticed. In contrast, it turned out to have a strong negative impact in the decades following the one in which it was first spotted. The exact number of years before phylloxera substantially reduced wine production varies from one *département* to the other. Since a common pattern does not clearly emerge, it would be very difficult to define a phylloxera indicator that would properly capture the speed of the epidemic spread. This would require making strong assumptions on the shape of the contagion process within *départements*. We thus choose to resort to a more neutral criterion and use as a cut-off point the year when each *département* was fully contaminated by phylloxera. This criterion allows us to focus on the effects of the crisis at its paroxysm. We thus define our phylloxera indicator as follows: it is equal to 1 as soon as the *département* is completely affected by phylloxera and remains so until 1890, the year when the solution to the disease – discovered in 1888 – was implemented on the entire French territory.

Figure 7 reports the co-efficients estimated using the model described in (1) where $P_{d\tau}$ are now defined as dummy variables for each cumulative number of years since phylloxera fully contaminated *département d*. Once the aphid invaded the whole geographical unit, we observe a clear fall in wine production.

In order to gauge the size and dynamics of the potential effects of full phylloxera contamination on crime rates, we estimate the following model that keeps the structure of (1).

$$c_{dt} = \alpha_t + \beta_d + \sum_{\tau=0}^{k} \gamma_\tau P_{d\tau} + \varepsilon_{dt}, \tag{2}$$

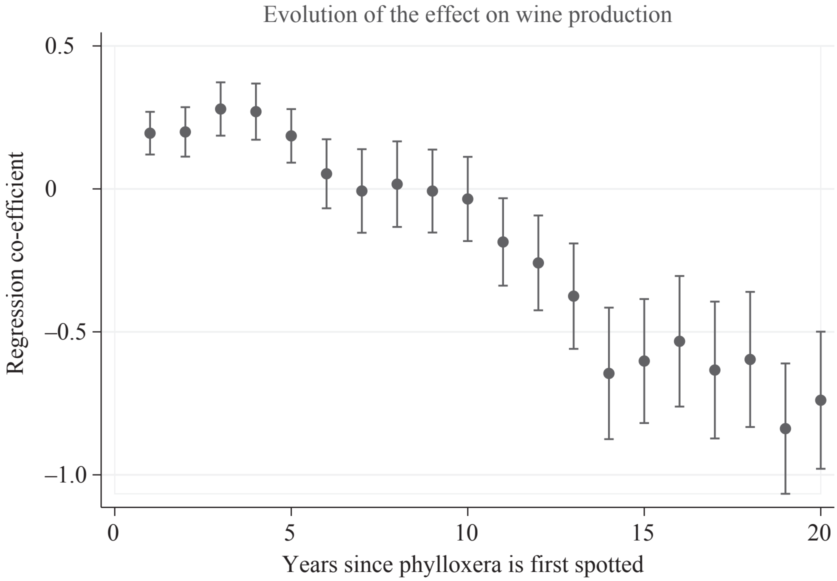

Fig. 6. *Impact of the Diffusion of Phylloxera on Wine Production – Since Phylloxera Was First Spotted in the Département*

where c_{dt} denotes the crime rate of interest (violent or property crimes) and $P_{d\tau}$ are indicators of each cumulative number of years of phylloxera since the first year the *départment* was fully contaminated.

Figure 8*a* reports the γ_τ coefficients in the case of property crimes while Figure 8*b* reports coefficients for violent crimes. The overall picture emerging from these graphs is that phylloxera had a positive effect on property crimes and a negative effect on violent crimes. Moreover, its impact on crime rates appears to increase with the number of years since the *départements* were fully contaminated, before levelling off eventually.

This graphical analysis is useful to get an idea of the timing of the effects of the crisis. The epidemic took some time to set up and the patterns of diffusion varied across geographical areas, but once the parasite affected the whole geographical unit, we observe a clear negative impact on wine production. As regards crime rates, the decrease in wine production seems to map into an increase in property crimes and a reduction in violent crimes. Interestingly, on average, phylloxera seems to reach its strongest effect both on wine production and on property crime rates between the 5th and 10th year after it fully affected *départements*.

In order to estimate the average effects generated by the phylloxera epidemic and to allow for some robustness checks, we now present standard regression analysis.

4. Average Effects of the Phylloxera Epidemic

In this Section, we present the results of a set of standard regressions where our main explanatory variable is full contagion by phylloxera defined as a dummy variable equal to 1 for all years between the year when a *département* was fully contaminated by

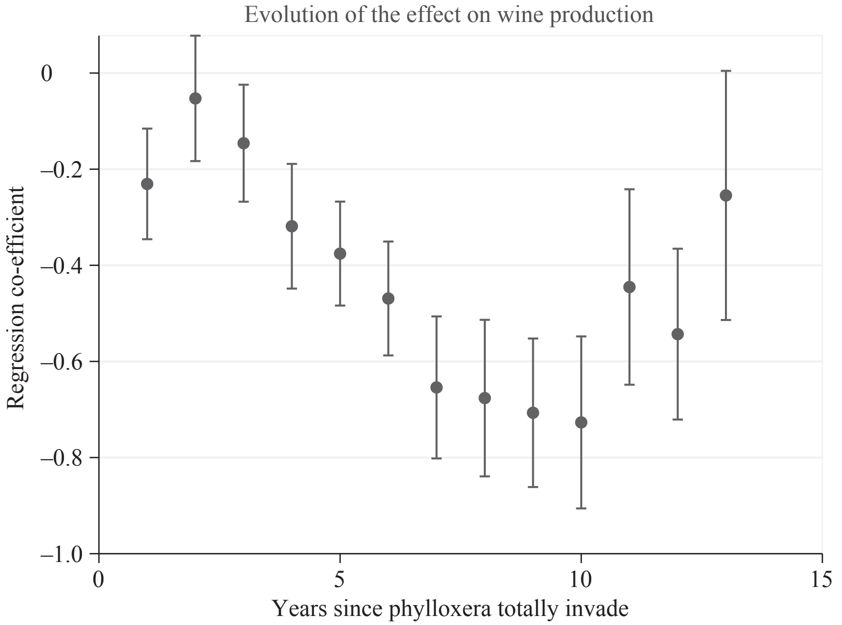

Fig. 7. *Impact of the Diffusion of Phylloxera on Wine Production – Since Phylloxera Fully Contaminated the Département*

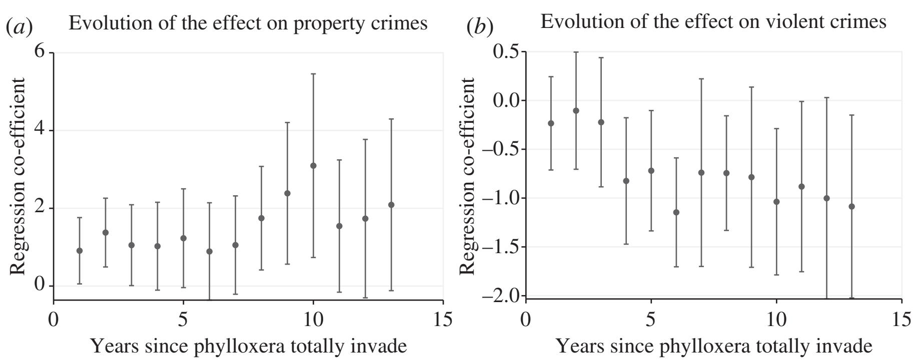

Fig. 8. *Impact of the Diffusion of Phylloxera on Crime*

phylloxera and 1890, and 0 otherwise. Our baseline model is:

$$c_{dt} = \alpha_t + \beta_d + \gamma PhyTot_{dt} + \varepsilon_{dt}, \tag{3}$$

where c_{dt} is the crime rate of interest (either violent or property crimes or minor offences), α_t and β_d are time and *département* fixed effects and $PhyTot_{dt}$ is our phylloxera indicator defined above. This choice is driven by the fact that, as described in the previous Section, we cannot use the year phylloxera was first spotted in a *département* as the cut-off point for contagion since the epidemic spread out slowly and in the first years after the aphid was first spotted in a *département*, it did not entail a large shock on wine production.[15]

4.1 *Phylloxera and Wine Production*

Before presenting reduced-form estimates of the impact of our phylloxera indicator on crime rates, we assess the average impact of full contamination by phylloxera on wine production. We estimate the following model:

$$\log(wp_{dt}) = \alpha_t + \beta_d + \gamma PhyTot_{dt} + \varepsilon_{dt}, \quad (4)$$

where wp_{dt} denotes wine production. The results, reported in Table 1, show that full contamination by phylloxera generated a major decrease in wine production: it was on average 35% lower in the years of full contagion by phylloxera as compared to the reference period characterised by zero or partial contagion.[16] In wine-intensive *départements*, defined as those *départements* where wine production amounted to at least 15% of agricultural production in 1862, the effect is even stronger since we observe a decrease in wine production by about 49%.

These results show that the phylloxera pest provides an ideally strong exogenous shock on wine production. This shock turns out to be stronger than that generated by meteorological changes used in a number of papers in the literature (Chevet *et al.*, 2011).

Table 1
Impact of Phylloxera on Wine Production 1850–1905

	Log (wine production)	
	Whole sample	Wine-intensive *départements*
Phylloxera – full contamination	−0.349***	−0.487***
	(0.102)	(0.119)
R-squared	0.876	0.706
F-stat	11.71	16.75
Observations	3,866	1,860

Notes. Information on wine production is available for 1850–1905. Over that period, once conditioning on having no missing values on phylloxera and wine production, sample size is 3,866. Wine-intensive *départements* are defined as *départements* in which wine production represented at least 15% of agricultural production in 1862 (38 *départements*). When considering only those *départements*, sample size goes down to 1,860. All specifications include year and *département* fixed effects Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

[15] Banerjee *et al.* (2010) use an alternative strategy to overcome the lack of common lag structure capturing the time span taken by the insect to spread out. They define a phylloxera indicator which takes the value 1 when phylloxera has been spotted in the *département* and wine production is at least 20% lower than in the last pre-phylloxera year. Although all our results are robust to this specification (available upon request) this does not appear as an appropriate solution in our case since wine production might be directly affected by crime rates thus introducing a reverse causality bias.

[16] These results are in line with Banerjee *et al.* (2010) who find a 35% drop in wine production using a different indicator of phylloxera.

4.2. *Phylloxera and Crime*: *Baseline Results*

In Table 2 we present the results obtained when estimating our baseline crime equation (3). All specifications include time and *département* fixed effects with standard errors clustered at the *département* level.[17] Columns (1)–(3) report the results for aggregate crime categories over the period 1826–1936. As evidenced in column (2), phylloxera had a positive and significant impact on property crimes. Moving from zero or partial contagion to full contagion by phylloxera increased property crime rates by 1.326 per hundred thousand points, that is an average increase of +18%. This suggests that the negative impact of phylloxera on legal earnings opportunities dominated its potential damage to the quality of illegal activities. Although we do not have data on unemployment for nineteenth century France, these results are consistent with articles showing that the quality and quantity of legitimate employment opportunities are pro-cyclical and negatively related to crime rates (Cook and Zarkin, 1985; Mocan and Bali, 2010).

Interestingly, the opposite effect is found for violent crimes – see column (1): full contagion by phylloxera reduced violent crime rates by about 12%. As highlighted in the conceptual framework Section, there exists a growing literature showing that:

(*i*) alcohol consumption is pro-cyclical; and
(*ii*) there is a positive relationship between alcohol consumption and violence.

Our findings are consistent with this evidence: phylloxera contributed to lower alcohol consumption that in turn, reduced, violent crime rates. To support this interpretation further, we collected data on alcohol consumption at the national level for the period 1831–1936.[18] Based on this information, we run a regression of alcohol consumption at the national level on the proportion of *départements* fully contaminated by phylloxera in a given year. Results, provided in online Appendix Table A2, show that, consistent with our interpretation, the spread of the phylloxera epidemic was associated with a decrease in alcohol consumption (with a point estimate of –1,539 and a standard error of 839.8). In turn, alcohol consumption per inhabitant appears to be positively associated with higher violent crime rates (with a point estimate of 3.66e–06 and a standard error of 2.01e–06).[19] This result is consistent with Traxler and Burhop (2010) who showed for nineteenth century Germany that when rainfall used to be particularly strong thereby generating an increase in rye prices – used to produce beer – violent crimes went down. However, the negative effect of rainfall on violent crimes vanishes once controlled for beer consumption. Together with our results, this suggests that, when hit by a negative income shock, people reduce their consumption, including that of alcoholic drinks. As a consequence, they engage less often in violent behaviour. As

[17] Results are essentially unchanged when including department-specific linear time trends. They are also robust to double clustering at the *département* and year levels in order to take into account potential geographic-based spatial correlation in the spread of phylloxera (Cameron *et al.*, 2011).

[18] Data on alcohol consumption at the national level are taken from Lederman (1964). Unfortunately, equivalent data are not available at the *département* level.

[19] These results are significant at the 10% level only which is not surprising, given the limited number of observations that we have (99).

Table 2
Impact of Phylloxera on Crime Rates

	1826–1936			1826–1912					
	Violent crimes	Property crimes	Minor offences	Homicides	All thefts	Thefts in churches	Thefts on country roads	Domestic thefts	Other thefts
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Phylloxera – full contamination	−0.599***	1.326***	−1.862	−0.134	1.354***	0.0293	0.0312	0.305*	0.936***
	(0.179)	(0.483)	(27.03)	(0.0878)	(0.466)	(0.0208)	(0.0376)	(0.162)	(0.328)
R-squared	0.536	0.642	0.512	0.619	0.603	0.079	0.163	0.535	0.564
Observations	8,639	8,639	8,639	7,038	7,038	7,038	7,038	7,038	7,038

Notes. Information on aggregate crime categories is available over the period 1826–1936 for 8,847 observations. When conditioning on having no missing values on the phylloxera variable, sample size goes down to 8,639. Information on detailed crime categories is available for different time spans according to the category. In order to keep the period constant across all variables, we consider the shortest time period for which data are available for all of them, that is 1826–1912. Over that period, crime data are available for 7,208 observations. Once conditioned on having no missing values on the phylloxera variable, sample size goes down to 7,038. In each crime category, dependent variables are defined as the number of individuals charged over the total *département* population in a given year. All specifications include year and *département* fixed effects. Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

underlined by Mehlum *et al.* (2006, p. 373), 'this is the likely channel that reduces violent crime'.[20]

In contrast, phylloxera does not seem to have affected minor offences (see Table 2, col (3)) the coefficient on the phylloxera variable is insignificant at conventional levels.

Evidence regarding more disaggregated types of crimes is consistent with these initial findings (see Table 2 – columns (4) to (9)) for the period 1826–1912. The impact of full contamination by phylloxera on homicides was negative, although not quite significant. In contrast, phylloxera increased the number of thefts per inhabitant (see column (5)). The epidemic is associated with an increase in all the theft categories recorded in the data but it is significant at conventional levels only for domestic thefts (at the 10% level) and a residual category including, among others, violent thefts (at the 1% level).

In order to check the sensitivity of our results with respect to the time window that we use, we re-run our main specification on a reduced time span centred on the phylloxera epidemic, that is 1850–1905. Results, reported in online Appendix Table A3, are very similar to those provided in Table 2.[21]

In order to gauge the impact of the negative shock on wine production triggered by the phylloxera epidemic better, we also run some IV estimates. We regress *département*-year crime rates on the log of *département*-year wine production instrumented by our phylloxera indicator – first-stage estimates are reported in Table 1 (column (1)).[22] The exclusion restriction underlying this empirical strategy is that phylloxera affected crime rates only through its impact on wine production. Table 3 reports the results for both aggregate and detailed crime categories. They are consistent with those presented in Table 2 and obtained by estimating the reduced form (3). Wine production – instrumented by full contagion by phylloxera – has a negative and significant impact on property crimes (at the 10% significance level) and a positive and significant impact on violent crimes (at the 5% significance level). The IV coefficients allow us to estimate the elasticity of crime rates with respect to wine production. To the extent that wine prices did not vary much over the phylloxera period – as underlined in subsection 1.1 – they may be interpreted as elasticities of crime rates with respect to income arising from wine-related activities. Under this assumption, the elasticity of property crimes with respect to wine-based income turns out to be as high as −35%. The corresponding figure for violent crimes is +21% and 0.3% for minor offences – insignificant at conventional levels.

In order to better understand the role of local structures of agricultural production in our findings, we run difference-in-difference estimates in which we compare the impact of full contagion by phylloxera in *départements* where wine

[20] In contrast, alcohol consumption is unlikely to account for our results regarding property crimes. According to Carpenter (2007), heavy alcohol use causes the commission of property and nuisance crimes. In the context of the phylloxera crisis, this suggests that property crimes should have decreased since alcohol consumption went down. This is not what we find in our data since phylloxera appears to have positively – rather than negatively – affected property crime rates.

[21] More generally, all the results presented in the rest of the Section are robust to restricting the time window of our estimates to 1850–1905.

[22] The estimates are run for the period for which we have information on wine production, that is 1850–1905.

Table 3

Impact of Wine Production on Crime Rates: IV estimates 1850–1905

	Violent crimes	Property crimes	Minor offences	Homicides	All thefts	Thefts in churches	Thefts on country roads	Domestic thefts	Other thefts
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log of wine production	1.019**	−2.576*	24.95	0.0448	−2.209**	−0.0462	−0.131	−0.530	−1.368**
	(0.451)	(1.374)	(52.21)	(0.207)	(1.079)	(0.065)	(0.102)	(0.415)	(0.687)
Observations	3,866	3,866	3,866	3,866	3,866	3,866	3,866	3,866	3,866
R-squared	0.477	0.490	0.613	0.527	0.376	0.052	0.037	0.368	0.387

Notes. Information on all types of crimes is available for 4,597 observations over the period 1850–1905. Once conditioned on having no missing values on phylloxera and wine production, the sample size goes down to 3,866. All specifications include year and *département* fixed effects. Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In each crime category, dependent variables are defined as the number of charged individuals over the total *département* population in a given year.

growing represented a large proportion of economic activity and in *départements* where this was not the case. As a first step, we interact our phylloxera indicator with the share of wine in agricultural production in 1862 (columns (1) to (3) in Table 4). Our results suggest that phylloxera had a larger impact on property crimes in *départements* where wine initially represented a large share of agricultural production. In contrast, the negative effect of phylloxera on violent crimes does not seem to vary according to the share of wine in agriculture. We also find a significant differential effect of phylloxera on minor offences in wine-intensive *départements*. Full contagion by phylloxera seems to have reduced minor offences in *départements* where the share of wine in agricultural production was initially very small but this effect becomes positive for *départements* in which wine production was important. At this stage of the analysis, it is not easy to understand why the phylloxera crisis may have induced a decrease in minor offences in non-wine-intensive *départements*. As suggested by further results presented in subsection 4.3 (Table 8) this may be due to the fact that, on average, judges in charge of minor offences became tougher, when *départements* got fully contaminated by phylloxera, whereas this did not happen for violent and property crimes. This may have generated a deterrence effect that dominated in *départements* which were not much dependent on wine-related activities. In contrast, in *départements* strongly dependent on wine, the effect of deterrence turned out to be smaller than the impact of the reduction in legal labour opportunities.

As a second step, we interact our phylloxera variable with the area planted in vines per inhabitant in 1862 (columns (4) to (6)) and with the share of people employed in agriculture according to the 1861 census multiplied by the share of wine in agricultural production in 1862 (columns (7) to (9)). This variable is a rough proxy of the proportion of the local population whose revenue is directly affected by wine production. Overall, the results are very similar to those obtained in columns (1) to (3): the impact of phylloxera on property crimes and minor offences is relatively more important in *départements* where wine represented a larger share of the local pre-phylloxera economy, except for property crimes in column (5). In contrast, the reduction in violent crimes following phylloxera does not seem to vary according to the initial importance of wine-related activities.

Taken together, these results suggest that the negative income shock induced by the phylloxera crisis strongly affected French crime rates. It caused a substantial increase in property crimes while inducing a decrease in violent crimes probably due to a reduction in alcohol consumption.

4.3. *Discussion and Robustness Checks*

In the previous Section, we provided evidence that the diffusion of phylloxera was associated with an increase in property crime rates and a decrease in violent crimes. We have maintained that the main channel driving our results is a negative shock on the income of people whose main source of revenue was related to wine production.

Although we do not have information on income at the *département* level, we can estimate the correlation between the proportion of *départements* fully contaminated by phylloxera and real aggregate GDP. Results are reported in online Appendix Table A4.

Table 4

Differential Impact of Phylloxera 1826–1936

	Violent crimes	Property crimes	Minor offences	Violent crimes	Property crimes	Minor offences	Violent crimes	Property crimes	Minor offences
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Phylloxera–full contamination	−0.765***	0.209	−79.70**	−0.518*	0.455	−70.24*	−0.766***	0.243	−59.90
	(0.242)	(0.644)	(37.74)	(0.271)	(0.666)	(41.72)	(0.250)	(0.745)	(47.30)
Phylloxera–full contamination × share of wine in agricultural production	0.724	4.896**	341.1***						
	(0.806)	(2.316)	(98.15)						
Phylloxera–full contamination × hectares of vines per inhabitant				−0.615	6.580	516.6**			
				(1.915)	(4.397)	(199.5)			
Phylloxera–full contamination × % of agricultural workers weighted by share of wine in agricultural production							1.262	8.225*	440.6*
R-squared	0.536	0.642	0.513	0.536	0.642	0.513	0.536	0.642	0.513
Observations	8,639	8,639	8,639	8,639	8,639	8,639	8,639	8,639	8,639

Notes. Information on aggregate crime categories is available over 1826–1936 for 8,847 observations. When conditioning on having no missing values on the phylloxera variable, the sample size goes down to 8,639. All specifications include year and *département* fixed effects. Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In each crime category, dependent variables are defined as the number of charged individuals over the total *département* population in a given year.

They show that the more *départements* fully contaminated by phylloxera, the lower the aggregate level of total GDP and GDP per capita. This is consistent with the idea that the destruction of vineyards by phylloxera generated a major income shock in affected *départements* as already discussed in subsection 1.1.

In order to make sure that phylloxera does not capture the effect of other time-varying factors, one may want to include a number of control variables. Socio-demographic controls are natural candidates. Such variables are available for Census years only (see Section 2), so that we re-estimate our baseline equation for five-year moving averages computed around Census years – see (3). As a first step, we check that this new specification does not modify our findings. As evidenced in Table 5 (panel (*a*), columns (1) to (3)) our results are unchanged: moving from no-phylloxera to full contagion increases property crimes and reduces violent crimes in a significant way. Introducing controls for the share of males in the departement population and for the age structure of the male population yields virtually identical results (see panel (*a*), columns (4) to (6)) This is not much of a surprise given that, in order to bias our results, socio-demographic factors should have been correlated both with crime rates and with the expansion of phylloxera, which was indeed quite unlikely. Urbanisation may be a more serious concern if its intensity varied a lot across *départements*. Panel (*b*) of Table 5 controls alternatively for the share of the *département* population living in towns larger than 2,500 inhabitants and the proportion living in the three largest cities in the *département* (for the standard definition of towns in France, see Section 3). Both specifications leave our results unchanged: phylloxera still increases property crimes and reduces violent crimes. These estimates show that our results are not driven by major changes in socio-economic characteristics.

Another concern could arise if full contagion by phylloxera generated migrations of individuals with specific characteristics. In order to check for this, we estimate the impact of phylloxera on changes in the share of specific demographic groups – in particular, men and young men – who are considered to be more likely to commit crime in the literature – see Levitt and Lochner (2001) and Buonanno *et al.* (2011) – and on the proportion of people living in urban areas where higher crime rates are usually observed (Glaeser and Sacerdote, 1999). More precisely, we regress the change in each of the population variables between two Census years on the proportion of years the *département* was fully contaminated by phylloxera since last Census.[23] Results are reported in Table 6. They show that the intensity of contagion by phylloxera in a given period did not induce significant changes in the composition of the local population. This suggests that phylloxera did not induce significant migrations of individuals who may be more crime-oriented or living in areas where crime is more frequent. This evidence is consistent with the idea that the impact of phylloxera on crime rates was driven by changes in the existing population's behaviour rather than by changes in the population itself.

[23] This is the best we can do since demographic variables come from the Census and hence are available every five years only. Given this limitation, the proportion of years the *département* was fully contaminated by phylloxera since the previous Census captures for how long a *département* has been fully contaminated by phylloxera since the Census last took place: it is equal to 1 if full contagion has been observed for all years since last Census and to $2/5 = 0.4$, for example if full contagion has been observed for the last two years only.

Table 5

Impact of Phylloxera on Crime Rates Controlling for Socio-demographic Structure and Urbanisation 1851–1911 (five-year moving averages)

	Violent crimes	Property crimes	Minor offences	Violent crimes	Property crimes	Minor offences
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (a): with socio-demographic controls						
Phylloxera – full contamination	−0.443** (0.189)	0.889** (0.395)	−22.96 (17.57)	−0.511*** (0.179)	0.981** (0.433)	−32.95 (20.22)
Socio-demographic controls	No	No	No	Yes	Yes	Yes
R-squared	0.676	0.746	0.639	0.720	0.750	0.652
Observations	1,081	1,081	1,081	1,081	1,081	1,081
Panel (b): with socio-demographic controls + urbanisation						
Phylloxera – full contamination	−0.503*** (0.176)	0.986** (0.430)	−32.29 (20.10)	−0.509*** (0.1767)	0.982*** (0.429)	−32.82 (20.20)
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Proportion of people in towns > 2,500	Yes	Yes	Yes	No	No	No
Proportion of people in three largest towns in the *département*	No	No	No	Yes	Yes	Yes
R-squared	0.752	0.752	0.659	0.722	0.751	0.656
Observations	1,081	1,081	1,081	1,081	1,081	1,081

Notes. Crime and phylloxera variables are measured as five-year moving averages around the Census years (i.e. 13 years spanning over 1851–1911) for which we have information on socio-demographic variables and urbanisation. Information on crime, socio-demographics and urbanisation is available for 1,081 observations over 1851–1911. In each crime category, dependent variables are defined as the number of charged individuals over the total *département* population. Socio-demographic controls include the proportion of males in the whole *département* population and the age structure of the male population (aged 15–19, 20–29, 30–39 years old and 40 years old and above). All specifications include year and *département* fixed effects Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

According to our interpretation, the positive effect of phylloxera on property crime rates was mainly driven by the deterioration of the quality and quantity of labour opportunities which induced a number of people to increase their amount of illegal activities with respect to legal ones. An alternative mechanism consistent with our results would be related to the response of the criminal justice system to crime. Reduced national and local tax collection during bad times may result in reduced budgets for police forces and a subsequent reduction in the capacity of the criminal justice system to contain crime. In order to control for this potential alternative mechanism, we include police forces measured at the court-of-appeal level in our regression. Results are reported in Table 7. The coefficients on property and violent crimes are essentially unaltered with respect to the baseline results. This suggests that police forces are unlikely to have been endogenous, which is consistent with the fact that their allocation was mainly determined at the national level. This test allows us to rule out that our results are driven by a radical change in the presence of police forces at the local level as a consequence of the phylloxera crisis.

Table 6

Impact of Phylloxera on Socio-demographic Characteristics 1851–1911

	Change in the proportion of men between 15 and 19 years old since last Census	Change in the proportion of men between 20 and 29 years old since last Census	Change in the proportion of men between 30 and 39 years old since last Census	Change in the proportion of men older than 40 since last Census	Change in the proportion of men since last Census	Change in the proportion of people in towns > 2,500 since last Census	Change in the proportion of people in the three largest towns in the *département* since last Census
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
% of years of full contamination by phylloxera since last Census	1.27e-05 (0.000877)	−0.000435 (0.00256)	6.81e-05 (0.00151)	0.000589 (0.00349)	−0.000155 (0.000741)	−0.147 (0.174)	−0.169 (0.223)
R-squared	0.038	0.069	0.040	0.039	0.039	0.255	0.243
Observations	996	996	996	996	996	996	996

Notes. There are 13 censuses and hence 12 observations for each *département* for variables computed as 'difference since last census'. Our database contains 85 *départements*. Moreover, Alsace *départements* only have four censuses (hence three observations here) before the 1870 war; Nice and the two Savoie *départements* have missing observations for two censuses since they were incorporated to France in 1860 only. So, overall our database contains 996 observations. The explanatory variable is the proportion of years a *département* has been fully contaminated by phylloxera since the last Census. It captures how long a *département* has been fully contaminated by phylloxera since the Census last took place: it is equal to 1 if full contagion has been observed for all years since last Census and to 2/5 = 0.4, for example if full contagion has been observed for the last two years only, since Censuses take place every five years. All specifications include year and *département* fixed effects. Robust standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Another alternative mechanism through which the phylloxera crisis could have affected crime rates is the behaviour of judges. During bad times, judges and juries could be more lenient towards those committing property crimes as they might justify misbehaviour as a consequence of the need to survive. If this were the case, the overall deterrence of the criminal justice system would be reduced as a consequence of the phylloxera attack. Note that in order for changes in leniency to account for our findings, judges should also have become tougher on people committing violent crimes. In order to check for this alternative explanation, we re-run our baseline equation with conviction rates as a dependent variable. Results provided in Table 8 show that our phylloxera indicator does not significantly predict conviction rates for violent and property crimes. As such, more lenient or tougher judges are not likely to account for our main results.

As evidenced in column (3), things are quite different for minor offences: the coefficient on the phylloxera indicator is positive and significant. As mentioned above, the deterrence effect generated by this change in judges' behaviour may account for the fact that full contagion by phylloxera induced a drop in minor offences in

Table 7

Impact of Phylloxera on Crime Rates, Controlling for Police Forces 1843–1932

	Violent crimes	Property crimes	Minor offences
	(1)	(2)	(3)
Phylloxera – full contamination	−0.327**	0.862**	−13.60
	(0.136)	(0.377)	(17.88)
Polices forces	Yes	Yes	Yes
R-squared	0.559	0.628	0.571
Observations	6,896	6,896	6,896

Notes. Data on police forces are available for the period 1843–1932 only. Over that period, the information on aggregate crime rates is available for 7,071 observations. Once conditioned on having no missing values on police force and phylloxera variables, the sample goes down to 6,896. All specifications include year and *département* fixed effects. Standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Table 8

Impact of Phylloxera on Conviction Rates 1826–1936

	Violent crimes	Property crimes	Minor offences
	(1)	(2)	(3)
Phylloxera – full contamination	−0.204	−0.248	0.919***
	(1.202)	(1.131)	(0.310)
R-squared	0.293	0.188	0.724
Observations	8,585	8,447	8,639

Notes. Over the 1826–1936 period, conviction rates are available for 8,791 observations for violent crimes, for 8,648 observations for property crimes and 8,847 observations for minor offences. Once conditioned on having no missing values on the phylloxera variable, sample sizes go down to 8,585, 8,447 and 8,639 respectively. All specifications include year and *département* fixed effects. Standard errors clustered at the *département* level in parenthesis. ***significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

départements which were not much dependent on wine-related activities. The difference we find for conviction rates between minor offences and crimes may be explained by some institutional characteristics of the French judicial system. Violent and property crimes were judged by criminal courts in which juries were composed of randomly drawn registered voters who decided both on guiltiness and mitigating circumstances, while professional judges were responsible for deciding sentences. In contrast, for minor offences, both jurors and court presidents were professional judges – appointed by the Ministry of Justice – who may have tried to counterbalance the potential effect of local economic conditions on minor offences.

5. Conclusions

This article studies the effects of a large negative income shock on crime using a unique dataset based on nineteenth century French administrative crime records at the *département* level. Our case study focuses on the effects of the phylloxera crisis, which caused a major shock to the French economy at a time when it was still largely dependent on agriculture. We provide evidence on the effects of the spread of the phylloxera epidemic both on wine production and on criminal activity. Our results show that the phylloxera crisis generated a strong increase in property crime rates, plausibly driven by the impact of phylloxera on the economic conditions of those living in the affected *départements*. These results are robust to various alternative explanations including possible changes in the criminal justice system or in the local presence of police forces following the phylloxera crisis. Our findings are consistent with the standard economic model of crime and suggest that property crimes, and in particular thefts, tend to increase as a response to negative income shocks when holding constant the other determinants of the individual propensity to commit crime.

Moreover, we show that the diffusion of phylloxera brought about a substantial decrease in violent crime rates consistent with the idea that the income shock induced a drop in alcohol consumption. This finding is in line with results by Mehlum *et al.* (2006) and Traxler and Burhop (2010) who provide evidence of a reduction in violent crimes following the fall in beer consumption brought about by bad rye crops in nineteenth century German states.

Our findings underline the fragility of economies that are heavily dependent on a given economic activity as were many French wine-producing regions at the time of phylloxera. This is not specific to the nineteenth century and investigating the impact of recent major downsizing events (e.g. in the automobile or steel sectors) or even municipality bankruptcies on crime rates in areas in which these industries (local authorities) accounted for a large share of local employment appears as a promising avenue for future research.

Banque de France
LEDa–LEGOS at Université Paris Dauphine, Paris School of Economics and IZA
OSC– CNRS and Sciences Po

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Additional Supporting Information may be found in the online version of this article:

Appendix A. Additional Tables.
Appendix B. Data Appendix.
Data S1.

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