Economic Crises and the Lender of Last Resort: Evidence from 19th century France*

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Abstract

This paper shows that a central bank can more efficiently mitigate economic crises when it broadens eligibility for its discount facility to any safe asset or solvent agent. We use difference-in-difference panel regressions and emulate crises by studying how defaults of banks and non-agricultural firms were affected by the arrival of an agricultural disease. We exploit the specificities of the implementation of the discount window to deal with the endogeneity of the access to the central bank to the arrival of the crisis and local default rates. We find that broad eligibility reduced significantly the increases of the default rates when the shock hit the local economy. This effect is identified independently of changes in policy interest rates and the fiscal deficit.

J.E.L. Codes: E32, E44, E51, E58, N14, N54

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1. Introduction

This paper analyses the design of a lender of last resort facility. It studies the benefit of granting broad and direct access to the lender of last resort, compared to a counterfactual situation in which the central bank intervenes through a small number of eligible counterparties or allows only a restricted subset of financial assets as collateral in its lending. Results show that the central bank stabilizes income shocks if it lends freely against the widest range of collateral and to the broadest number of (solvent) economic agents.

The optimal design of central bank intervention aimed at mitigating economic crises is subject of age–old controversy since Bagehot (1873). Indeed crises often feature temporary extensions of eligibility to previously ineligible counterparties like non-banks or to assets that normally would not be accepted in central bank operations. Quantitative evidence on the beneficial impact of those extensions is limited. This paper fills this gap. Based on evidence from a quasi natural experiment, we show that the central bank can best intervene to soften the impact of a crisis when it allows the broadest possible access to its lending of last resort facility. Our setup identifies the positive effects of central bank intervention independently of the implementation of any counter-cyclical fiscal policy or interest rate change. Finally, the intervention does not require bailing out (subsidizing) the eligible assets or sectors, be they distressed firms or banks.

The theory supporting lending of last resort emphasizes its beneficial impact either when the payment system is threatened by a crisis (Flannery, 1996) or in the case of a run on financial intermediaries (Freixas, Rochet, and Parigi, 2004). Subsequent research studying the optimal design of the access to the lender of last resort emphasized the trade-off between the benefits in terms of stabilization and the costs in terms of moral hazard (Chapman and Martin, 2013, Bindseil and Jablecki, 2013) or if there is a stigma associated to the use of central bank facilities (Armantier, Ghysels, Sarkar, and Shrader, 2015). Our paper focuses on the role of lending of last resort in protecting the payment system and is consistent with the view that lending of last resort helps alleviating crises when the central bank can screen the quality of its counterparties.

Our paper also echoes the papers in monetary theory that study whether changes in the composition of the asset side of the central bank balance sheet affect real allocations. Changes in the asset side of the central bank balance sheet matter when financial markets are segmented (Gertler and Kiyotaki, 2010, Cúrdia and Woodford, 2011) or when money is more liquid than the debts purchased by the central bank (Chamley and Polemarchakis, 1984, Kiyotaki and Moore, 2005, Venkateswaran and Wright, 2014).[1] We show empirically that the composition of the central bank balance sheet and the design of the operational framework can positively affect the economic outcome.

Our empirical design allows studying whether a greater variety of safe assets purchased by the central bank allows attenuating the increase of the default rate when some geographical area is hit by an economic crisis. In order to be able to isolate the effect of eligibility on the economic outcome the empirical test requires two ingredients. First, there must be an aggregate negative shock that increases the demand for money (lending of last resort) and that is not explained by agents taking more risks in expectation of the access to the lender of last resort facility (thus excluding that our result are driven by moral hazard). Second, the shock must hit several economies that differ with respect to the degree of eligibility to the central bank but otherwise are all subject to identical monetary and fiscal policies. We claim that a natural experiment in 19th century France combines these two ingredients.

Our empirical strategy is as follows. We study a negative productivity and capital shock that hit different French districts (*départements*) at different points in time. The shock was brought about by an agricultural disease caused by the insect phylloxera that nearly killed all vines in an economy in which wine production was widespread (Banerjee, Duflo, Postel-Vinay, and Watts, 2010). Wine production decreased significantly. Neither the fiscal authority nor the central bank attempted to attenuate the effects of the collapse of wine production (Bignon, Caroli, and Galbiati, 2016). The agricultural productivity shock translated into an aggregate shock on local banking systems as well as services and industry (Postel-Vinay, 1989). To identify the effects of eligibility to central bank operations we exploit a peculiarity of 19th century central bank operations where eligibility was tied to geographical criteria and thus differed across districts. As the arrival and spreading of phylloxera was a clearly exogenous event we can exclude that the crisis was triggered by moral hazard behavior linked to expectations of eligibility extensions. Econometric identification is helped by the fact that the shock brought

[1] Wallace (1981) established the irrelevance result stating that exchanging one debt (money) against another (e.g. government debt) leaves unchanged the real allocation. Chamley and Polemarchakis (1984) show that the irrelevance result hinges upon the assumption in Wallace (1981) that money does not provide transaction services. Recent research has clarified that the irrelevance result is overturned if the central bank can screen the assets with the same level of expertise than other financial market participants, see for example (Williamson, 2014).

by phylloxera affected some districts more than others and did not arrive everywhere at the same time thus allowing to better control for other confounding factors. Finally, we exclude a potential counter-cyclical impact of fiscal policy by working with a case in which the government did not intervene.

Our analysis uses a uniquely rich administrative hand-collected dataset documenting the number of defaults and the stock of non-agricultural firms in each of the 85 districts as recorded by the ministry of justice and the finance ministry. We also have information on the inclusiveness of the eligibility rule at the district level. Our panel includes yearly data spanning over the 1826 to 1913 period. At the high point of the pandemia, which ravaged France from 1863 to 1890, 71.3% of districts were infected.

We run two types of panel regressions. First, we show that the crises of local economies triggered by phylloxera significantly increased defaults of non-agricultural firms. Second, we regress the default rate of non-agricultural local firms on the depth of the local economic crisis, a measure of the inclusiveness of the eligibility for the central bank and an interaction term. Results show that districts with broader eligibility for the central bank experienced a less marked increase in the default rate of banks and firms in services and industry than did districts with stricter eligibility rules. The results are robust across various specifications and to the correction for spatial autocorrelation in the error terms. We exclude that eligibility was endogenous by showing that variations in eligibility at the district level were uncorrelated with the spread of the disease, measures of the economic crisis triggered by phylloxera or variations in the district default rate. Finally, we show that the central bank did not make losses on its extended discount operations. The observed decrease in the default rate was thus due to central bank eligibility only and not to a quasi-fiscal subsidy by the central bank.

The rest of the paper is organized as follows. Section 2 presents our empirical strategy. Section 3 discusses the identification assumptions on eligibility that are rooted in the historical analysis of the financial and banking system of 19th century France and on the exogeneity of the economic crises that is linked to the spread of the phylloxera pest. Section 4 presents the data sources. Section 5 describes the spread of the negative shock. Section 6 discusses the statistical and economic significance of the results, and the robustness checks. Section 7 concludes.

2. Empirical strategy

Our goal is to determine whether variations in the proportion of assets eligible for the central bank discount window had an impact on the variation in the default rate of banks, services and industry at the district level when the economy was hit by the phylloxera crisis. We estimate this relation using a difference-in-difference approach. Our main equation is the following:

$$DR_{it} = \delta_t + \alpha_i + \delta_t \cdot \alpha_i + \beta \cdot Shock_{it} + \gamma \cdot Elig_{it} + \eta \cdot Shock_{it} \cdot Elig_{it} + \xi Controls_{it} + \epsilon_{it} \quad (1)$$

where DR_{it} stands for the default rate in district i during year t of banks and firms operating in services or industry. The explanatory variables are $Shock_{it}$, which measures whether the district was hit by an exogenous shock that generated an economic crisis in district i during year t, $Elig_{it}$, which measure the exposure of district i to the treatment during year t and the interacted term $Shock_{it} * Elig_{it}$, which is the product of the variable $Shock_{it}$ with variable $Elig_{it}$. A vector of controls $Controls_{it}$ is added to account for variations of the default rate in the district during the year; see section 4.2 for details. All residuals are clustered at the district level.

The spatial structure of the data might raise concerns about the correlation of the error terms between districts, which in turn might bias the estimated coefficients or change the standard errors. In particular, there might be determinants of the dependent variable that were omitted from the model but that are spatially autocorrelated, meaning that the error term is correlated between nearby districts. To show the robustness of our result to the correction for potential spatial autocorrelation, we estimate the following model:

$$\begin{aligned} DR_{it} = \beta \cdot Shock_{it} + \gamma \cdot Elig_{it} + \eta \cdot Shock_{it} * Elig_{it} + \xi \cdot Controls_{it} \\ + \delta_t + \alpha_i + \delta_t \cdot \alpha_i + \lambda W \cdot \nu_t + \epsilon_{it} \quad (2) \end{aligned}$$

Equation 2 is identical to equation (1) with the difference that the error term v_{it} allows for spatial correlation between error terms. W denotes a spatial weights matrix based on the distance between the capital cities of the districts, where we assume a declining impact of errors from districts that are further away. λ measures the extent of spatial correlation, where zero means that there is no spatial correlation and a higher λ means stronger spatial spill-overs.

Finally we check the endogeneity of the $Elig_{it}$ variable to either the default rate DR_{it} or the shock variable $Shock_{it}$ by estimating a Cox duration model explained in details in section 6.3.

3. Historical background

We first discuss how we exploit a peculiarity of the 19th century French financial system to construct a measure of eligibility to central bank operations that varies at the district level (3.1). We then turn to explain why the phylloxera-induced crisis is a good quasi-natural experiment to exclude that the local economic crisis it triggered was caused by moral hazard or the expectation of a central bank bail-out (3.2).

3.1. Eligibility of assets to the lender of last resort

In 19th century France, two debt instruments were widely used to finance economic activity, but banks were exposed to only one type of debts (Hoffman, Postel-Vinay, and Rosenthal, 2015). Long-term investments were financed with (very) long term loans. Typically, loans such as mortgages were granted by wealthy persons (typically non-banks) to other non-bank agents. Mortgage loans were not intermediated by banks but by notaries who acted as matchmakers between lenders and borrowers (Hoffman, Postel-Vinay, and Rosenthal, 2001).

We focus on the other class of debt which was the bills of exchange. Bills of exchange were a special class of short term debt and were the principal instrument in banks' balance sheets (Kaufmann, 1914). It also serves the role of means of payment (Roulleau, 1914). In French law, a bill was an order to pay some amount of money to the bearer at some pre-determined future date in some specified location (Dalloz, 1830). Bills of exchange were negotiable and could be sold at face value, a deduction being made for the interest rate, the so-called discount. In this process, the previous owner (the discounter, usually a bank) of the bill signed the bill thereby guaranteeing the following purchaser of the bill to pay in case of a default of the ultimate debtor. this exposed banks to the bills' default risk. A bill could be discounted several times, at every turn receiving an additional signature and thus guarantee.

The law required the owner of a bill to collect the payment of the bill at the debtor's door. Financial intermediaries that held bills to maturity therefore had to set up an organization to collect payment at the debtor's door within a given geographic area at the contractually-agreed date. The possibility to buy and hold bills to maturity was constrained by the size of this area since payment collectors have to physically go to the debtor's place.[2] Therefore eligibility was restricted to assets payable in locations where the central bank (or deposit banks) operated. As this technology did not change significantly during the whole 19th century, the extension of the assets eligible for discounting was tied to the setting-up of local collection facilities, most importantly in the form of branch offices. To single out the causal impact of variations in the eligibility of bills of exchanges for the refinancing on the default rates, we exploit the fact that the fixed cost of setting up and operating branches prevented banks from opening them everywhere, see also *infra* in section 6.3. This naturally created spatial variations in eligibility.

Discounting required putting "some skin in the game". In French law, the discounting of bills was a risky activity because it exposed the discounter to the default risk of the debtor, even after the bills had been resold to someone else. The scheme was as follows. Holders of bills were liable of the collection of the payment at maturity at the debtor's door. If the debtor defaulted by not paying at maturity, the French jurisprudence endowed the creditor (the holder of the bill) with the right to immediately activate the guarantees, once the creditor had proven the inability of the debtor to pay, using a simple procedure called protest (*"protêt faute de paiement"*), see Tate (1868). With the protest in his hand the creditor was immediately allowed to ask for the payment at the home of every discounter who by discounting the bill had guaranteed payment, and finally if they also failed at the initial creditor of the bill (Bravard-Veyrières and Demangeat, 1862).[3] At most the guarantee had to be activated within a couple of days.

Default was harshly punished (Dalloz, 1830, Percerou, 1935). As long as the creditors had not been entirely reimbursed, debtors were not allowed to restart and manage

[2]Note that unlike other financial intermediaries who could sell on (rediscount) bills, the central bank was forced to hold bills to maturity.

[3]According to French law there were three relevant parties to a bill: The *tireur* drew a bill on the *tiré* (debtor) against whom he had a previous claim. To obtain cash before the due date the *tireur* passed on (discounted) the bill with a *escompteur*, typically a bank, who now became the creditor. The *escompteur* could either hold the bill in his portfolio and demand payment from the *tiré* when the bill fell due or rediscount the bill with another bank or the Bank of France, which now became the new creditor. In order to be eligible for rediscount at the Bank of France the bill had to carry three signatures, typically the signatures of the *tireur*, the *tiré*, who by his signature (*acceptation*) acknowledged the validity of the claim, and the *escompteur*. In case of non-payment by the *tiré*, these signatures allowed the Bank of France (or any other creditor holding the bill at maturity) to take recourse against the other two parties.

any business. In a failure procedure, if creditors agreed on debt restructuring and to allow the continuation of the debtor's business (under a *"concordat"*), the defaulter did not recover his commercial and civil rights before the full reimbursement of the debts. These provisions made strategic default very costly.

The possibility to immediately activate guarantees in case of non-payment made bills of exchange a safe and liquid instrument, at least as long as the firms were expected not to default. In a failure procedure, bills of exchange did not benefit from an opt-out clause, which meant that creditors had to wait up until the end of the procedure to recuperate the proceeds of their debt (Percerou, 1935). Even though creditors on average recuperated a significant percentage of their claim when the procedure ended, a normal length of the procedure between one and two years meant that any exogenous increase in default increased the percentage of illiquid debts in the economy and hence the likelihood of being unable to repay the debt in due time. Anecdotal evidence abounds that when payment incidents started, it was difficult to prevent them because of the stay of creditors in a lengthy procedure and the impossibility to exit it before its legal termination.[4]

Two types of financial institutions had the organization and technology to smooth regionally concentrated illiquidity-driven defaults by redistributing liquidity across districts: the few deposit banks operating on a national scale or the central bank. Both could have increased discounting in branches located in crisis-hurt districts using either the deposits of agents living in crisis-free districts, in the case of deposit banks, or the right to issue banknotes, as in the case of the central bank. An important difference between deposit banks and the central bank was that the opportunity cost of resources must have been much smaller in the case of the central bank. Both types of banks used the same technology to screen and monitor the discounting of short-term bills, although the central bank discounted on harsher terms, usually at a higher rate and with higher credit standards (Bouvier, 1973).

The central bank – the Bank of France – was a publicly listed company endowed with the monopoly of banknotes issuance in France. Its goal, according to its charter, was to refinance bankers and any other types of traders on demand. To this end it purchased bills of exchange outright.[5] The Bank of France did not buy bills on a

[4]Honoré de Balzac' novel *César Biroteau* exemplified this issue.

[5]Banknotes could also be obtained through collateralized lending, called advances (*"avances sur titres"*), where agents pledged some publicly traded securities such as railway or government securities. For the sake of simplicity, the discussion here focuses on discounting but the argument is not affected

market with open-market operations. Rather, discounting was organized as a standing facility where the Bank of France stood ready to purchase bills on demand in its offices from agents in need of cash. The Bank's incorporation law restricted the Bank to buy bills maturing within the three months that followed the purchase. The purchase price was determined by the nominal of the bill minus the discount rate times the residual maturity. The discount rate could not be adjusted to local conditions or specific risk profile of the counterparties, which means that the bank could only deny eligibility to lower-quality bills rather than demanding a risk premium.[6] The volume of rediscounting and the discount rate were decided by the governing body of the Bank in Paris in which private shareholders had a two-third majority over the representatives of the government (Plessis, 1985). The bank paid dividends every semester to its private shareholders and was formally independent of the government.

The central bank was allowed to vary its discounting decisions depending on its judgment on the good standing of the traders. In a country into banking was not regulated, the law restricted eligibility to any firm specialized in either banking, services or industry. No bills payable by a farmer could have been discounted by the Bank of France before rules were amended in 1898. Because bills were held to maturity, the Bank had to collect the payment of the bills at maturity. This required either the payee to keep an account with the Bank of France or the Bank to send an officer to collect the payment when due. It followed that only bills payable in a city in which the Bank of France operated a branch were eligible for its discount window. Another consequence was that the share of local traders eligible for the discount window varied across districts because of the technological constraint created by the specificities of the payment of bills of exchange at maturity.

The discount of bills was made in a Bank's branch office (*"succursale"*). Between 1815 and 1836 the only office operated by the Bank of France was in Paris, which de facto restricted discounting to bills payable in Paris. Hence opening a branch in a city not only allowed more agents to be eligible as a counterparty of the bank but it also made more bills eligible, thereby extending the share of assets – among all assets – against which central bank money could be obtained. Figure 1 presents the evolution of the number of branches operated by the Bank of France between 1826 and 1913. In each district the number of branch varied between 1 (mostly agricultural districts) and 9 (in the highly industrial district "Nord"). The increase in branches corresponded to

if one considers the collateralized lending facility as well.

[6]See the 1808 decree on the statute of the bank.

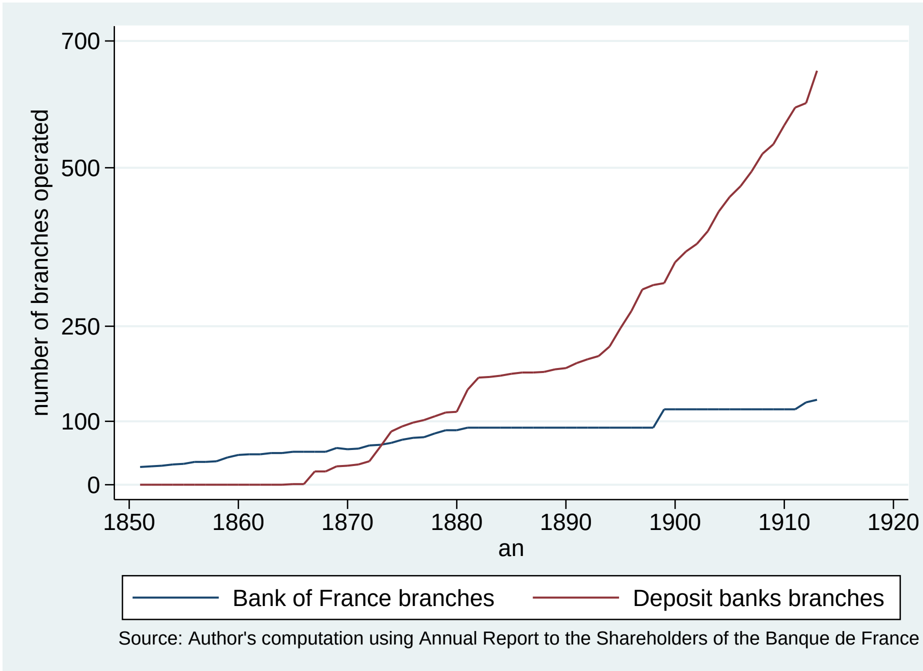

Figure 1: Number of branches operated by the Bank of France and the two main national deposit banks, 1850–1913

a geographical extension of the branch network, which increased the number of eligible counterparties and the share of bills eligible for central bank rediscounting. We use this restriction on the access to the central bank to compare the impact of economic crises across regions depending on the eligibility for the discount at the Bank of France. Section 6.3 discusses the policy of branch opening by the Bank of France and shows that the Bank did not vary its eligibility policy with the arrival of the economic crises we study or with the level of the default rate.

Starting in the 1860s, deposit banks also developed extensive networks of branches (see figure 1), with the aim of collecting deposits and discounting local bills of exchange. Most deposit banks operated an internal capital market on which branches located in liquidity-stressed district could borrow the funds necessary to discount bills (Billoret, 1969). The national deposit banks thus competed with the Bank of France in their discount activity, as discussed extensively in the literature, see Bouvier (1973) and Lescure (2003).

3.2. Economic crises: Phylloxera, the bug that shocked local economies

The second ingredient in our quasi experimental setting is the negative productivity shock brought about by the arrival of an agricultural disease in economies in which agriculture was the most important source of income. Once phylloxera arrived in a district, the disease started destroying the vineyards, reducing local wine production and making wine growers poorer (Banerjee et al., 2010, Bignon, Caroli, and Galbiati, 2016). As a result, defaults in services and industry increased.

The disease was caused by the near microscopic aphid *phylloxera vastatrix* – literally the killer of the vineyard – which sinks its pointed snout into the roots of the vine and sucks out the sap. Its saliva infects the roots at the attacked points preventing the wound from healing. This way phylloxera not only causes yields to fall to zero, but kills the plants themselves within short time. The approximate time between the arrival of the pest and the death of the plant was about a year (Pouget, 1990).

Phylloxera started infecting French vineyards in 1863 (Gale, 2011, p. 18) and then spread gradually onto the French territory. The effects of the aphid were first noticed in 1863 near the Rhone river in the South of France, and soon thereafter in the Bordeaux region. Figure 2 and 3 show the geographic spread of the disease between 1871 and 1877. Yet the speed of destruction was not uniform across time and space. For example between 1871 and 1879 the south-east district known by the name of Gard lost 83% of its vineyards while the neighbouring Hérault lost only 59% (Lachiver, 1988, p. 416).

It took a long time to understand why the vines were dying and even longer to understand what could be done about it. The insect was first hypothesized as an explanation to the dying vines in 1868, after the study of a dead vineyard near the Rhône by the botany professor Jules E. Planchon. After that identification, a debate raged for seven years before the scientific community agreed that the bug was in fact the cause and not just a consequence of the disease. Academics tried various treatments to fight the pest but none proved helpful for winegrowers (Pouget, 1990). It is only in 1890 that a cure was found and popularized. The solution involved grafting European vines onto phylloxera resistant American stock.

The arrival of phylloxera caused a brutal drop of wine growers' revenues. In a mostly agricultural country, the share of wine production amounted to 6.4% of the pre-aphid 1862 GDP. In 1870, wine represented a source of income for 21% of the population (Millardet, 1877, p. 82). The impact of phylloxera varied a lot across districts, as

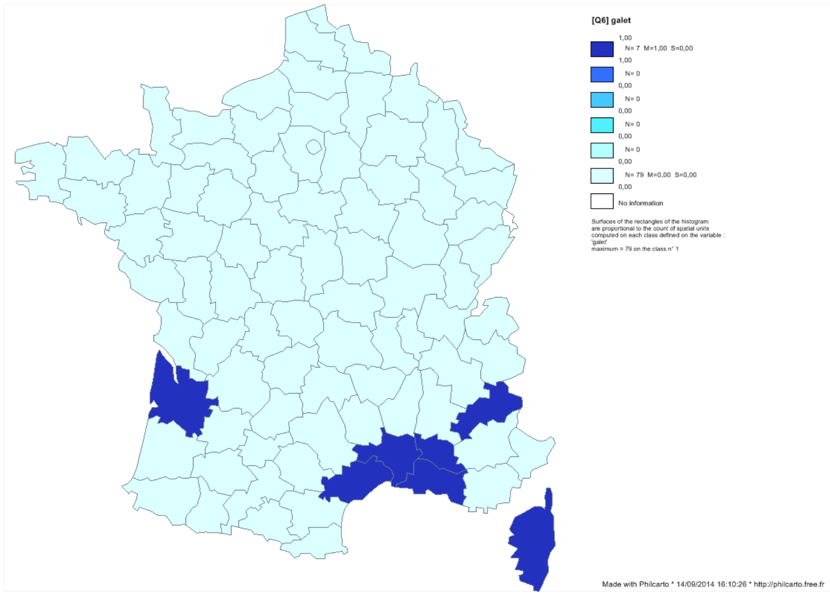

Figure 2: Districts infected by the phylloxera in 1871

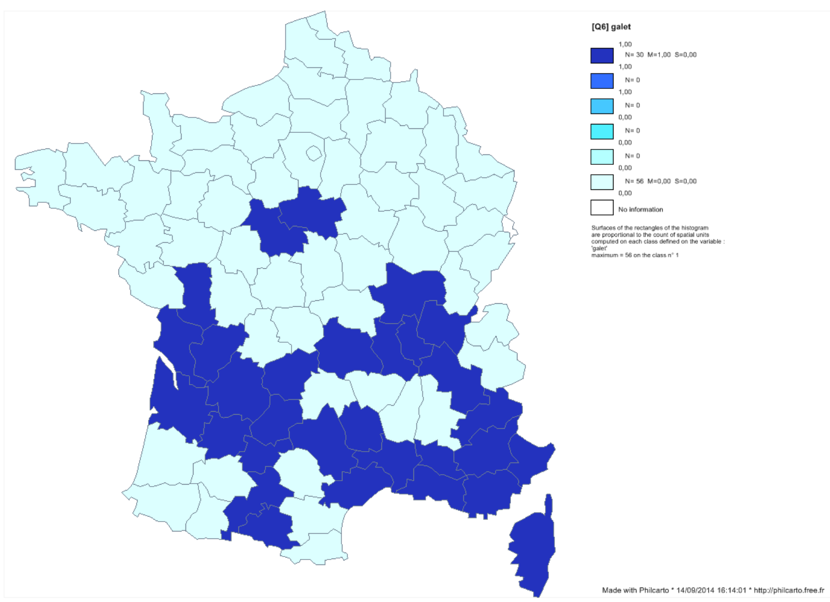

Figure 3: Districts infected by the phylloxera in 1877

some of them did not grow any vines, while wine production could reach up to 54% of district GDP in others. On average wine production represented 9.2% of GDP in wine producing districts. By 1890 the revenues from wine production had dropped to 2.75% of French GDP, see Figure 4. In some regions the impact of the aphid onto local economies was disastrous (Postel-Vinay, 1989) in particular as price increases did not compensate for the fall in quantity (Bignon, Caroli, and Galbiati, 2016). Figure 5 plots the distribution of the share of the district wine production as percentage of district GDP in 1862.

At the same time, the shock induced by phylloxera did not impact consumers' budgets as the consumption price of wine did not increase markedly for three reasons, see Bignon, Caroli, and Galbiati (2016).[7] First, wine imports increased sharply. Second the practice of vine cultivation spread quickly in the (phylloxera free) French colonies in North Africa, notably Algeria. Third various wine adulteration techniques were allowed to maintain the total quantity of alcoholic beverages created from the pressing of grapes.[8]

The impact of the phylloxera on agriculture was smoothed neither by fiscal nor monetary policy. The central bank was prohibited from lending against any assets that had been originated in the agricultural sector. Fiscal policy was of little help either: the state spent one million Francs a year on phylloxera at the apex of the disease in the 1880s and this little money was directed toward scientific research Loubere (1978, p. 172). Moreover, no welfare programs such as unemployment benefits existed to absorb parts of the revenues losses. As a result the shock created by phylloxera on agriculture was transmitted to the other sectors of the French economy and decreased the other sectors' revenues.

The length of the episode (from 1863 to 1890) made it impossible for farmers to maintain consumption by drawing on their savings. It was also very unlikely that farmers had been able to increase their saving in advance of the income shock. This would have required a clear understanding of how the disease would spread and of its cause, an issue that was not settled before 1875 (Gale, 2011, chapter 1). Even then, historical evidence shows that the general agreement that the aphid caused the disease did not make the French wiser in using the spread of the insect over the territory as a signal for future losses. The literature identifies two reasons for this lack of foresight.

[7]For example the price of wine in Paris was pretty stable during the whole period.

[8]The second wines (called *piquette*) were produced by adding sugar to the cakes that remained after the first pressing. These second wines were sold on the market in the 1880s.

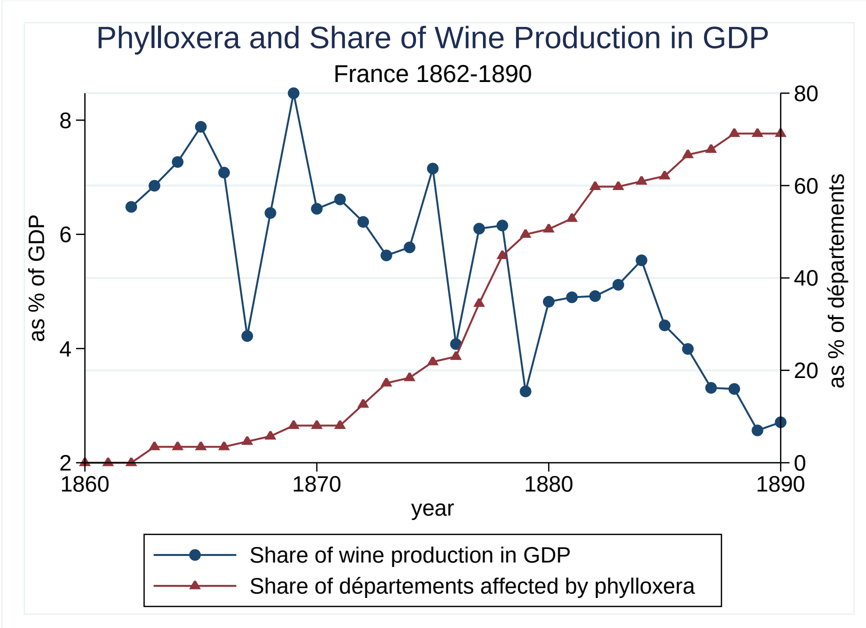

Figure 4: Revenues from wine production and the share of wine-producing districts infected by phylloxera between 1860 and 1890 (source: Bignon, Caroli and Galbiati, 2016)

Some peasants argued that the disease would be confined by nature to some regions, while others simply denied its existence, arguing that the disease could be avoided by taking good care of the vines (Gale, 2011, p. 52). Loubere (1978, p. 158) argues that such a blindness resulted from the policy of uprooting the diseased vines as a means to safeguard those still intact.

To sum up, the shock induced by phylloxera has several characteristics which provide for an ideal setting for analysing the effects of variations in central bank eligibility. (i) Phylloxera was a sizable real productivity shock on the agricultural sector, which ensures that the shock was transmitted to the other sectors and that the result was not driven by changes in expectations. (ii) The size of the shock had a discernable impact on the other sectors of the economy. (iii) The fact that phylloxera arrived in different districts at different moments in time allows us to analyse the effects of the crisis at a district level thereby increasing the number of observations and helping us to circumvent the small sample problem typical of other lending of last resort studies; (iv) The setting properly singles out the role of eligibility as fiscal policy and other aspects of monetary policy were not changed in response to the shock; (v) The clearly external nature of

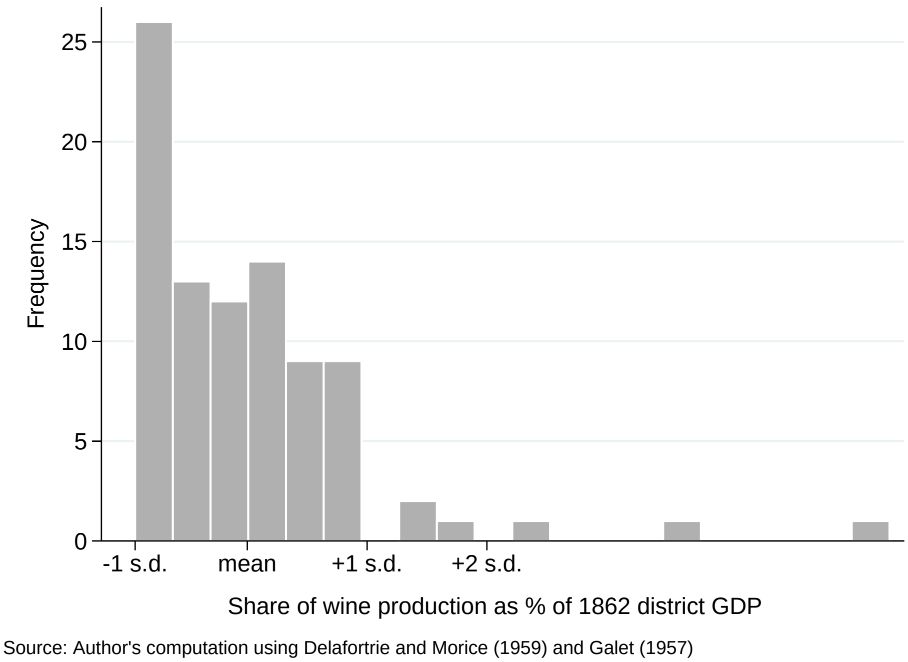

Figure 5: Frequency distribution of the share of wine production in the GDP of the district in 1862

the shock allows excluding reverse causality between eligibility and the economic crises caused by the disease; (vi) It is reasonable to consider the disease as a temporary income shock on banks, services and industry, as a cure to the disease was finally found; (vii) The gradual spreading of the disease facilitates the proper identification of the effect of the disease on the economy.

4. Data

The dataset contains yearly observations on the variables of equation (1): default rate DR_{it} (Section 4.1), yearly measures of the importance of the shock triggered by the spread of the phylloxera in each district $shock_{it}$ (Section 4.2) and measures of eligibility to the central bank and the two main deposit banks $elig_{it}$ (Section 4.3).

4.1. Default rate

For each district and each year, the number of defaults on debt repayment is known from the number of openings of a judicial procedure called failure (*faillites* in French).

According to both law and jurisprudence this procedure aimed at protecting the equality of all creditors when the debtor proved unable to pay one of its creditors. The procedure allowed creditors to screen the value of the assets, to ascertain the validity of the liabilities (so as to avoid some creditors to be impaired by made-up claims) and to decide on whether the business had to continue being operated or not, in which case the monetary value of the assets was shared between the creditors.[9]

The definition of a failure in French law has a number of convenient features for our empirical design. First, the opening of a failure procedure was tied to illiquidity and not to insolvency. Indeed, the law stated that a failure procedure could be opened only after the observable recognition of a default. This was to prevent anti-competitive or political interferences with the running of businesses, where some competitors could have demanded the opening of a failure procedure with the only aim to drive a competitor out of business. In their comments of the law, legal scholars made it clear that a presumed state of insolvency in itself could not be taken as a motive for the opening of such a procedure since insolvency could only be decided after a proper screening of assets and liabilities of the firm. Therefore the law opted for a criterium that could not be manipulated easily by outside parties and no judge could force an (allegedly) insolvent but liquid firm to file for a failure procedure (Percerou, 1935). As a consequence, the number of failure procedures opened clearly identifies the number of defaults in a given location during a given year.

Second, the number of new openings of the failure procedure gives the appropriate measure of defaults in services and industry. The reason is that only traders qualified for the procedure, while workers and other non-traders such as farmers or lawyers were excluded. Frontiers between the different activities were easily drawn. A trader —*commercant* in the legal definition— was defined as an independent business earning revenues from the selling for profit of products and/or services.[10] Defaults by workers or firms operating in the agricultural sector —farmers— were regulated in a different legal procedure. The distinction comes in handy here, because we are using an income shock to the agricultural sector to assess the effects of central bank liquidity support

[9]The creditors were assisted by a judge who had to keep the records of the events occurring during the procedure and to check the legality of the decisions taken by the creditors. The judge was assisted by an agent specialized in the screening of the assets and liabilities of the bankrupted firm. No creditor could opt out of the procedure before the creditors had voted on the outcome except by renouncing his claim.

[10]Examples include wholesalers, shopkeepers, insurers, bankers or manufacturers.

on the other sectors of the economy.

The number of defaults per district is known by counting the number of *faillites* openings during a year. The data appendix details the sources used to document them at the district level. It is worth noting that neither the definition of defaults counted as *faillites* by the administration nor the scope of businesses to which the law applied were changed during the 19th century. To compute the default rate, we divide the number of defaults by the stock of firms in services and industry active during each year in each district. The number of firms in services and industry was retrieved from statistics on the French business tax (*patentes*). The business tax was paid by every trader, i.e. any business selling goods or services for profit on the market, which again encompassed all shopkeepers, wholesalers, factories, craftsmen, and banking and insurance firms. Like in the statistics on defaults, the agricultural sector was exempted. The appendix details the sources from which the number of tax-payers were retrieved.[11]

4.2. Measures of the shock triggered by the spread of phylloxera

A year before the phylloxera aphid was first spotted in France in the *Gard* district in 1863, wine was produced in 79 out of the 89 French districts.[12] The 10 non wine producing districts were located in the Brittany, Normandy and the North of France. All other districts produced at least some wine. The shock triggered by the phylloxera disease on the other sectors of the local economy varied with the share of wine in the district GDP. In 40 districts, the share of wine in agricultural production was greater than 15% of local GDP.

To account for the size of the crisis at the district level, we construct different specification of the $Shock_{it}$ in equation (1) presented in section 2. Those specifications aim at measuring the size of the local economic crisis triggered by the agricultural disease in district i during year t. The crisis varies with the importance of wine in the local GDP of district i as well as the spreading of the disease within the district. As the speed with which the bug spread into each district varied across districts and time, no single lag structure can account for it. We present the propagation of phylloxera and

[11] The business tax was paid at the level of individual establishments. To ensure the comparability of the number of defaults with the stock of firms eligible for the default procedure, we have collected the number of *patentes* payers, i.e. the number of firms that paid the tax, and not the *cote des patentes* which measures the number of branches of business units paying the tax.

[12] Three districts had to be dropped from our analysis because some data was missing for them, leaving 86 districts in the sample.

its impact on wine production in section 5. To exclude that our results are driven by a particular choice of the lag structure we use three alternative variables to measure the size of the shock induced by phylloxera.

The simplest specification of $Shock_{it}$ is labelled $Spotted_{it}$ which is the product of two terms. The first term is a dummy that is set to 1 in any year between the first year the aphid was spotted in the district and the year of the implementation of the cure to the disease in 1890. In any year before the aphid arrived in the district and after the implementation of the treatment, we set this dummy to 0. In order to account for the different importance of wine for the economy of district i, the dummy is multiplied by a second term, which is set equal to the share of wine production in the 1862 GDP. As a result, $Spotted_{it}$ is equal to a constant term during the years phylloxera was present in district i and zero otherwise. Table 1 presents the descriptive statistics.

An alternative measure of the size of the local economic crisis is the variable labelled $impactdummy_{it}$ that controls for the significant time that could have passed between the first spotting of the aphid in the district and the moment at which it had led to widespread devastation of vineyards. In order to account for this, we use a dummy variable constructed by Banerjee et al. (2010). The dummy is set to 1, if the two following conditions are fulfilled. First, the aphid is present in the district. Second, wine production has fallen below the level reached during the last year before the arrival of phylloxera. As no direct information is available on the spread of the aphid within each district, the second condition aims at capturing that phylloxera must have spread sufficiently widely to have had an impact on wine output. Again, the dummy is set equal to 0 after the implementation of an effective treatment in 1890. Like in the case of $Spotted_{it}$, the dummy is multiplied by the share of wine production in the 1862 GDP in order to account for the different weight of wine in local economies. As a result, $impactdummy_{it}$ is equal to a constant term during the years when both phylloxera was present in district i and after wine production had declined relative to the pre-phylloxera benchmark level before 1890 and is zero otherwise.

A third alternative, which is our preferred variable, is labelled $impactvolume_{it}$ which is constructed as a continuous version of $impactdummy_{it}$ by taking into account the actual decline of wine production during the period where the phylloxera depressed wine production. To construct the measure, we use again a variable constructed by Banerjee et al. (2010). Our variable $impactvolume_{it}$ is the product of $impactdummy_{it}$ and the percentage decline in wine production relative to the level in the last year before the phylloxera was spotted in a district. Unlike $Spotted_{it}$ and $impactdummy_{it}$

that are either zero or a constant, $impactvolume_{it}$ varies with the actual decline in wine production during each year between the arrival of the disease in the district and 1890 and can thus take best account of the district-specific speed with which phylloxera was propagated.

4.3. Eligiblity measure for the lender of last resort

To measure the extent of access of local agents to the facilities offered by the Bank of France and the big deposit banks, we use two alternative specifications of $elig_{it}$, which are constructed for both the Bank of France and the deposit banks. The first is labelled $branches\#_{it}$ and uses simply the number of branches operated by either the Bank of France or the deposit banks within each district i during year t. Taking the simple number of branches is justified given that French districts were all of roughly equal size and had been designed in 1790 such that every point within the district was within a one-day horse ride from the district capital. In case more densely populated districts needed more branches to offer the same degree of access to the banking system, we also use an alternative measure labelled $branchescap_{it}$, which adjusts the number of branches for the population of the district.

5. Accounting for the spread of the phylloxera

Before presenting the results of our regressions, this section takes a more in-depth look at the dynamics of the spreading of phylloxera and how the different definitions of the variable $Shock_{it}$ presented in section 4.2 can capture these dynamics. The shock variable $Shock_{it}$ has to properly account for two dimensions: First, the date of the arrival of phylloxera and two, the severity of the shock on the local economy. While the year when phylloxera was first spotted in each district is well known, the time it took the aphid to spread over the district is not. Historians have noted that it took quite some time for the aphid to destroy a significant proportion of the vineyards in a given district and, thus, to potentially affect other sectors in the economy. In addition, historical evidence indicates that the speed with which phylloxera spread across districts varied considerably. Some feeling for the dynamics involved can be obtained by running the following regressions along the lines of Wolfers (2006), which allow the impact of

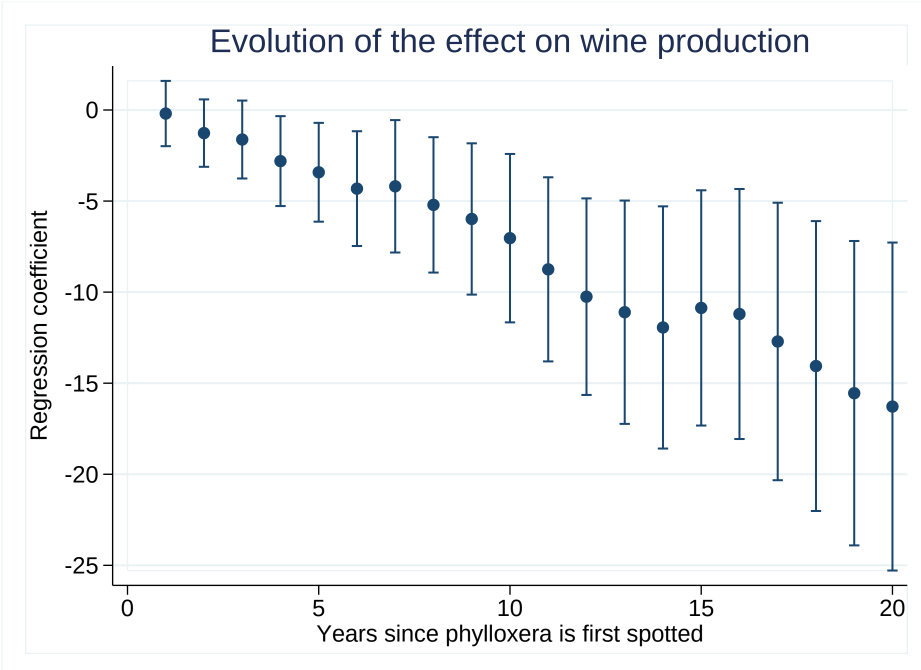

Figure 6: Dynamic effect of the spread of the phylloxera on wine production, 1863–1890

phylloxera to evolve over time:

$$Lprodwine_{it} = \alpha + \sum_{i \geq 1} \alpha_i Infect_i + \delta_t + \alpha_i + \delta_t * \alpha_i + \epsilon_{it}, \qquad (3)$$

where Lprodwine_{it} is the logarithm of wine production in hectolitres in district i and year t. Infect_i is defined for every district as a function of the first sighting of phylloxera in the district: The variable Infect_1 is set to 1 in the first year after the arrival of phylloxera in the district, Infect_2 in the second year and so on. Therefore i takes value between 1 and (at most for the district contaminated in 1863) 27. To control for structural differences between districts and shocks at the national level all regressions include time δ_t and district α_i fixed effects. District specific time trends $\delta_t * \alpha_i$ capture potential differences in the long-run evolution of wine production across districts. Finally, residuals are clustered at the district level, i.e. each regression controls for correlation among the observations of a given district. The coefficient and standard errors are plotted on figure 6. Inspection of the level reveals that phylloxera started to have a significant negative effect on wine production only four years after the first sighting of the aphid in a district.

A similar analysis can be undertaken for the relationship between the spread of

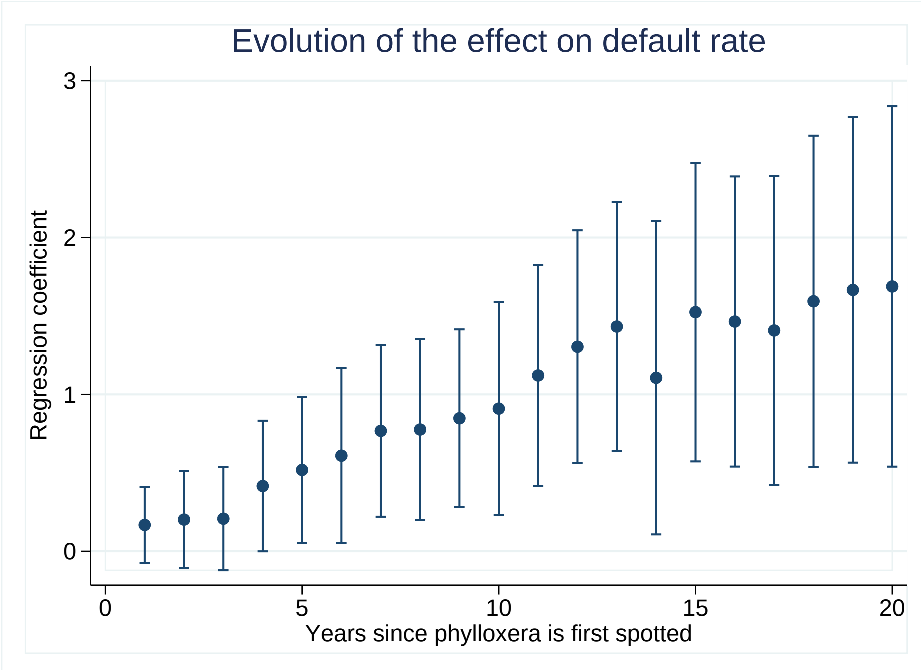

Figure 7: Dynamic effect of the spread of the phylloxera on district default rates of services and industry, 1863–1890

phylloxera and local economic distress by studying the dynamic impact of phylloxera on the default rate of non-agricultural firm. Hence the dependent variable is a pure measure of the indirect impact of the shock on the services and industrial sectors. The regression estimated with the following equation checks that the negative productivity shock on agriculture triggered an increase of the default rate in banking, services and industry.

$$DR_{it} = \alpha + \sum_{k \geq 1} \alpha_k Infect_i + \delta_t + \alpha_i + \delta_t * \alpha_i + \epsilon_{it}.$$

where DR_{it} is the default rate in district i and year t and the other variables defined as in the regression above. All the residuals are clustered at the district level.

Figure 7 plots the evolution of the regression coefficient α_k and its confidence interval. It shows that the shock created by the phylloxera significantly increased the default rate of firms in services and industry and that the impact increased over time. The coefficient becomes significantly different from zero five years after the aphid was first spotted in the district, and one year after phylloxera had led to a significant decrease in the wine production of the infected district.

Together, both results show that in the absence of any proper treatment to prevent the vines from dying, phylloxera led to a sharp decline in wine production, triggering a sufficiently high negative shock to the productive assets of farmers so as to cause local (macro) economic crises in the affected districts. The relatively long time it took for phylloxera to significantly affect local wine production and broader economic conditions as well as differing size of the impact, as evidenced by the relatively wide confidence intervals around Infect_i, help to better assess the relative merits of the different specifications of $Shock_{it}$ presented in section 4.2.

$Spotted_{it}$ is set equal to 1 from the first sighting of phylloxera until 1890, when a reliable treatment of phylloxera was found, while $impactdummy_{it}$ combines the sighting of phylloxera with a fall in wine production, which could take several years as shown in figure 6. $Impactvolume_{it}$ finally is allowed to vary from year to year in response to the fluctuations in production induced by phylloxera. One advantage of this specification is that because of climatic and geographical factors, wine production in some districts may have been more affected by phylloxera than in others. Moreover $impactvolume_{it}$ better accounts than the other two specifications for the impact of phylloxera crisis on the local income. The following baseline regressions thus use $impactvolume_{it}$ as explanatory variable, while $Spotted_{it}$ and $impactdummy_{it}$ are employed to check the robustness of the results.

6. Results

We present the main results in section 6.1, check the robustness of the main results in section 6.2 and discuss the exogeneity of the eligibility measure to both the default rate and the propagation of phylloxera in section 6.3.

6.1. Main results

The results of the estimation of equation (1) are reported in table **??** that use *impactvolume* as the crisis variable and the number of branch offices operated in the district *branches#* as the measure for eligibility. The first column reports the baseline estimate on the period 1826 to 1913, including year and district fixed effects as well as district-specific time trends. Residuals are clustered at the district level. The second column adds control variables. Column (3) restricts the estimation to the sub-sample of wine-intensive districts while column (4) looks at the sub-sample of years during which no cure to the phylloxera were available, i.e. to 1863 to 1890.

The key variable of interest ist the interaction variable between the depth of the crisis and the eligibility for the central bank. It is negative and statistically significant at the 1% level. This implies that an increase in the eligibility for the central bank significantly reduced the default rate when the phylloxera crisis hurt the district. The phylloxera crisis variable significantly increased the default rate of the industry, financial and services sectors, which is consistent with the view that the central bank did not try to avoid the default of all firms. Adding additional controls in column (2) do not alter these results. National rediscounting banks such as Crédit Lyonnais and Société Générale have no impact on the level of the default rate, and when the phylloxera crisis hurt, they even appear to have restricted lending pro-cyclically, thereby increasing the default rate of the industrial, services, and financial sectors. In any case, the coefficient on the interaction term is only weakly significant. The number of firms per 1,000 inhabitants and population density both proxy for local economic development and differences in the evolution of economic structures across districts (structural difference that do not change over time are already captured by the district fixed effects in the baseline regression). The coefficients on both variables are negative and statistically significant, implying that higher developed districts featuring more entrepreneurial activity were also ceteris paribus those with lower default rates.[13]

The results are therefore consistent with the view that eligibility for the central bank prevented to some extent the agricultural crisis to spill over to solvent but liquidity constrained firms in the rest of the economy. To assess the economic significance of this result, we perform the following counterfactual exercise. To this end we use the coefficient of the regression of table **??** column (2) to predict the evolution of the default rate in two counterfactual scenarios in which the Bank of France would have (1) operated no branches during the period of the spread of the phylloxera or (2) would have had opened in the year of the arrival of the phylloxera on the French territory in 1863 all the branches that it operated in 1913. Figure 8 compares the actual evolution of the default rate (at the aggregate level) together with the default rate in the two counterfactual scenarios. In the complete absence of Bank of France branches the default rate would have been 10% to 15% higher in the late 1870s, early 1880s. A reduction in the default rate by 10% to 15% is highly economically significant as there were many reasons for defaults other than phylloxera and/or could not be alleviated by central bank liquidity

[13] The variable $farmsize * shock$ accounts for regional variation in the size of agricultural business and the structure of wine growing that might lead to a different impact of phylloxera on regional income and liquidity provision. The coefficient is never statistically significant.

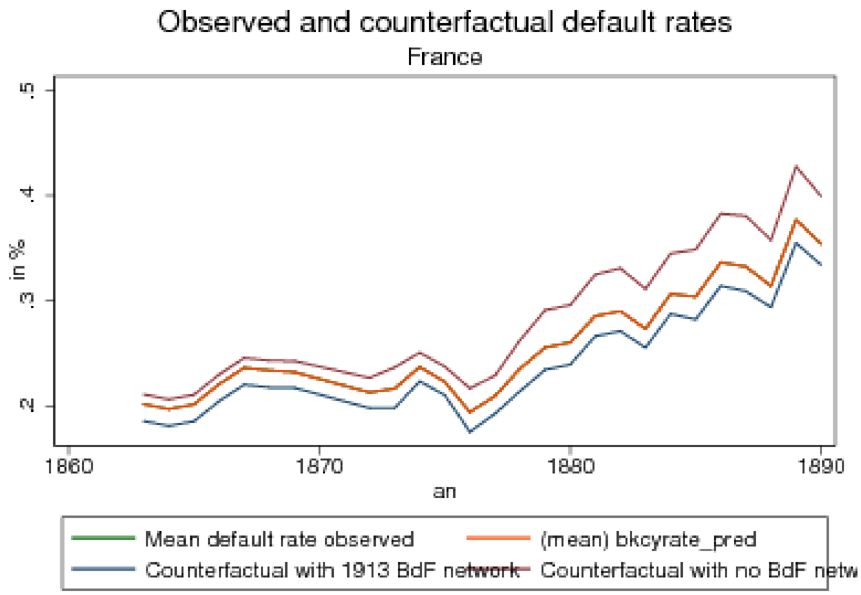

Figure 8: Observed and counterfactual default rates comparing the impact of having no branch or of having opened in 1863 all the branches operated in 1913 compared to the actual data

support. Conversely, the bank would have been even more successful in counteracting the crisis triggered by phylloxera had it had its 1913 network already in place in 1863.

6.2. Robustness checks

Tables 2–4 provide estimates with alternative specifications for the two key explanatory variables, the measure for central bank eligibility and the measure for the economic impact of phylloxera.

Alternative specifications for eligibility The estimations reported in table 2 reproduce those in table 1 with the only difference that access to the central bank as well as to the national deposit banks is now measured by the number of branches per capita *branchescap*. As *branchescap* is smaller than *branches#* the coefficients on the eligibility variable and the interaction term are bigger now. As can be seen, however, sign and statistical significance are unaffected by this alternative specification of eligibility.

Alternative specifications for the shock The same is true when alternative measures of $shock_{it}$ are used. Table 3 gives the results when instead of using $impactvolume_{it}$ the economic effects of phylloxera are measured using $Spotted_{it}$; table 4 when using $impactdummy_{it}$. Again the signs of all relevant variables are unaffected, both in the most parsimonious specification in columns (1) and the specification including additional controls in columns (2). The main difference to the specification using $impactvolume_{it}$ and reported in table 1 is that the coefficient on the shock measures, while correctly signed, is now sometimes not statistically significant. This result is not surprising given that both $Spotted_{it}$ and $impact_dummy_{it}$ are less precise measures for the impact of phylloxera than $impactvolume_{it}$. Importantly for the argument on the role of the Bank of France in mitigating the negative effects of phylloxera, however, the interaction term is correctly signed and highly significant with both alternative shock measures.

Restriction to wine-intensive districts only. In all tables 1–4 columns (3) provide an alternative specification excluding districts with only a small or no wine producing sector. We define as wine intensive all districts, where wine accounts for more than 15% of the total cultivated area. The main results are unchanged. The coefficients in front of the shock variable and the interaction term do not change or increase slightly and their level of significance remains unaffected or even increases somewhat.

Shorter time period. The second sub-sample looks only at the years from the arrival of phylloxera in 1863 until the identification of a cure in 1890. Even though the total number of observations is thus drastically reduced, the coefficients, reported in columns (4) of tables 1–4, are still correctly signed and the significance of the coefficient of the interacted terms is maintained.

Spatial autocorrelation. A last set of robustness checks concerns potential spatial correlation. The results of the estimation of equation (2) are given in table 6. We focus on the different eligibility and shock measures in the parsimonious specification and include the additional controls only when estimating the baseline model with $impactvolume_{it}$ as shock and $branches\#$ as eligibility variables. The inclusion of a spatial error term does not change the magnitude and statistical significance of the coefficients. A comparison of the coefficients in table 5 with the coefficients in the corresponding specifications without spatial error term in tables 1–4 shows that most coefficients and standard errors remain in fact completely unchanged. Spatial correlation has thus no bearing on the results presented above.

6.3. Exogeneous branching to default rates and phylloxera

In this section we exclude that the decision of the Bank of France to open new branch offices (the eligibility variable) was driven by the concern of alleviating the effects of phylloxera or conversely that the Bank hesitated to open branches in districts hit by the phylloxera crisis. We provide narrative and econometric evidence that branching was not influenced by phylloxera and that the estimated coefficients on the impact of access to the Bank of France on the default rate are not over- or underestimated.

Historians explain the gradual extension of the branch network of the Bank of France visible in figure 1 as the outcome of both political and competitive pressures (Pose, 1942, Bouvier, 1973, Plessis, 1985). After having taken over all provincial note issuing banks in 1848, the Bank of France enjoyed a monopoly of note issuance in the cities in which it operated a branch. This monopoly was only briefly contested by the Pereires brothers in the 1860s (Cameron, 1961, 138–144). Beginning in the 1860s, however, some commercial deposit banks, most notably Société Générale and Crédit Lyonnais, created their own large networks, soon covering the entire territory of France (Bouvier, 1973, Pose, 1942). These banks collected significant amounts of deposits that they employed in local discounting, thereby draining business away from the Bank of France (Lescure, 2003, p. 136-7). As competition for good bills was fierce in the larger cities, the Bank of France reacted by expanding its own network, refinancing smaller regional and local banks in more remote places (Nishimura, 1995).

A second motive was politics. The charter–in particular the note issuing monopoly–was granted to the Bank for specified periods of time. Whenever the charter came up for renewal, the Bank needed political support from the government and among lawmakers in parliament. Extending services at existing branches or opening new branches was a good way to buy support at the local level. As a consequence, all renewals included clauses that lead the Bank to extend its network. The renewing of the privilege of 1857 required the Bank to open at least one branch in every district, without setting a deadline. This was done in 1873, when the Bank was instructed to cover all districts by the beginning of 1877 at the latest (Plessis, 1985, p. 199-201). The charters of 1897 and 1911 again contained clauses requiring the opening of further branches (Pose, 1942). In addition, according to Lescure (2003), from the 1880s onwards, a new generation of bank officers saw the role of the Bank as being at the service of the public, and hence an obligation to ensure equal access to its services for all citizens of the country.

Accordingly the Bank of France not only expanded geographically, but implemented significant simplifications in the access to its discount and giro facilities (Leclercq, 2010). On the other hand, the opening of a branch was costly. In the 1890s the Bank estimated the set-up costs to be about 160,000 Francs, and the annual operating costs at 36,000 Francs for a small branch (Burdeau, 1892), at a time when the hourly wage of a qualified blue collar worker rarely exceeded 1 franc. Given the high set-up costs the Bank had to consider seriously the long-run viability of the new branch by obtaining information on the likely volume and risk characteristics of the local demand for (re)discounting. The opening of a branch also took time. The Bank had to find a building and recruit director and staff as well as the members of the committee that examined the bills submitted to discounting (*comité de censure*). Branch office opening typically required a lead time of one year and could hardly had been used to address an acute crisis.

As can be seen in figure 1, the network expanded gradually until the mid-1880s and was then extended significantly after 1897 and 1911. This pattern fits well with both mounting competition from commercial banks in the 1860s and the political economy of rechartering. To check the validity of this interpretation, we provide a formal test by estimating a duration model. The duration model studies the entire population of urban agglomerations in France of at least 2,500 inhabitants to estimate which characteristics were significantly associated with the opening of a branch by the Bank of France. The goal is to explain the time it took to the opening of a branch office. Duration analysis is appropriate as the Bank never closed a branch, i.e. the status of a city can only change from not having a branch to having one. This gives 782 potential cities among which the Bank of France could have chosen to operate branches in 1880.[14], of which 140 were selected by the Bank to open an discount facility office between 1830 and 1913. The regression model reads as follows:

$$Opening_{ijt} = \alpha \cdot Shock_{j,t-1} + \beta \cdot Pop_{i,j,t-1} + \gamma \cdot DR_{i,t-5_t-1} + \eta \cdot Bank_{i,j,t-1} + \lambda \cdot Surface_{i,j} + \delta \cdot Popdistrict_{i,j,t-1} + \lambda_1 \cdot CapCity_{ij} + \lambda_2 \cdot BoFpresent_{jt-1} + \epsilon_{ijt} \quad (4)$$

Equation 4 explains the opening of a branch in a city j of district i during year t where $Opening_{ijt} = 1$ if a branch was opened in the city during year t and else is

[14]The Bank never opened branches outside urban agglomerations Jobst (2010), Bazot (2014). The number of cities levelled between 727 in 1851 and 782 in 1913.

set equal to 0. Previous historical research summarized above suggests the inclusion of both political and economic factors as explanatory variables. In addition we include both an indicator for the presence of phylloxera and the default rate to see whether the spread of the disease and its economic consequences affected the Bank's behaviour. Because it took at least a year between the decision to open a branch and its opening to the public, all right-hand side variables are lagged by one or two years depending on the specification.

Economic factors accounted for the attractiveness of establishing a discount business in a given city. First, population $Pop_{i,j,t-1}$ of the city is a proxy for the size of the local economy. The population of the district $Popdistrict_{i,j,t-1}$ measures economic activity in the wider catchment area of a potential branch office, while the inclusion of the surface of the district $surface_{i,j}$ corrects for low or high population density. Competitive pressure is accounted for by a categorical variable $Bank_{i,j,t-1}$ indicating whether a deposit bank operated a branch during the previous year in the city or not.

The political variables capture the pressure coming from the need for a regular renewal of the charter. The 1857 charter, reinforced in 1873, required the Bank to open at least one branch in every district. As a consequence, the probability of a branch opening should be higher in districts if the district has no branch office yet. The dummy variable $BoFpresent_{jt-1}$ is zero if the Bank of France has no branch office in this city or in any other city of the district and one otherwise. Given that the 1857 charter of the Bank of France forced the Bank to open a branch in every district before 1878, it is likely that the bank would do so in the economically most important city of the district. This is accounted for by the variables $poprank1$, $poprank2$, etc. which are set to one for the largest, the second largest, etc. city in the district and zero otherwise. Dummy $CapCity_{ij}$ indicates whether the city is the capital city of the district, i.e. the seat of the central government representative (*prefecture*)[15]. It accounts for the possibility that political pressure would lead to the opening of a branch office in a politically rather than economically important city.

Finally we include two variables that look at the impact of local economic shocks and phylloxera in particular. $Shock_{j,t-1}$ is a dummy indicating whether the district was contaminated by the phylloxera during the previous year. The default rate variable $DR_{i,t-5_t-1}$ is included to check whether a local economic crisis increased or decreased the Bank's willingness to operate a local facility. To smooth year-on-year variations the

[15]District capital cities did not change during the 19th century.

default rate was averaged over the last five years from $t--5$ and $t--1$. Because of data unavailability at the city-level, the default rate and the shock variable are measured at the district level.

Table 7 presents the results of the estimations with a 1-year lag and table 8 those with a 2-year lag. Coefficients larger than one imply that the variable increases the probability a branch being opened. The district default rate and the phylloxera crisis variable are not significant, independently of whether they are included alone or together and whether further controls are added or not. In terms of economic factors, both higher district population increases the likelihood of a new branch being opened as well as the fact that one of the two main national deposit banks was already operating a branch. The coefficient on the absolute population of the city itself is not significant; however, population rank is. The probability of a branch being opened in the second largest city of the district is almost half of that in the largest city and probability declines rapidly when we turn to the third or fourth largest cities. The significance of rank reflects the tendency of the Bank of France to open branches in the biggest city in the district given the constraint that Bank had to open at least one branch in every district. As soon as one branch had been opened, the probability of further branches being created declined significantly, as evidenced by the coefficient on $BoFpresent_{jt-1}$ being much smaller than one. Lastly, being a capital city increases the probability of a branch opening by a factor of close to 5. The coefficients are unaffected with a 2-year lag, see table 8.

All in all the results are consistent with the historical narrative that the decisions by the Bank of France to open branch offices were unrelated to either the default rate or the spread of the phylloxera. More generally, it is likely that the high setup cost of branches and the difficulty to monitor the local discounting activity were a strong motivation for the Banque de France to avoid opening branches with the sole goal of mitigating temporary shocks.

6.4. Lending of last resort and the absence of bail-out

In this section we ask whether the central bank suffered any losses on its discount activity in distressed districts. To measure the risk taken by the Bank in its discount policy, we have collected the amount of protested bills discounted by the Bank of France, where protested means that the bills were not paid when due. Figure 9 plots the percentage of the Bank's portfolio and compares it to the percentage of protested bills at the economy-wide level. Inspection of the graph reveals that the proportion

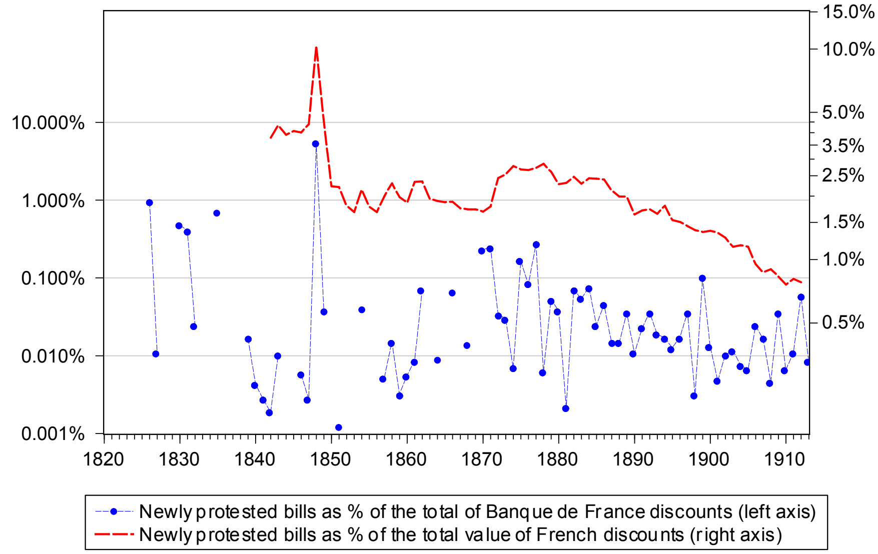

Figure 9: Unpaid bills at maturity as percentage of the discount activity of the Banque de France and of all the stamped bills issued in the economy (1860-1913)

of bills unpaid at maturity in the Bank of France portfolio stands at 0.015% during the period between 1820 and 1913. This level was much lower than the ratio at the economy-wide level, which averaged at 2.18% during the period from 1842 to 1912.

This is no surprise given the monitoring of risk that the Bank of France adopted when discounting bills and the screening of the counterparties involved. Because the Bank did purchase the bills of exchange outright, any default on payment at due date had a direct impact on the dividend. As a privately owned company traded on the Paris stock exchange, the Bank of France had a keen interest to screen the bills carefully in order to minimize its exposure to default so as to protect profitability.

The safety and liquidity of bills of exchange hinged on the number and quality of the endorsers. By putting his signature on the back of the bill, every endorser became liable to pay the bill at maturity if the drawee was in default.[16] The guarantee was easy and quite cheap to call on.[17] The percentage share of unpaid bills plotted in figure 9

[16]The law and jurisprudence carefully organized the transfer of ownership of bills that occur with each act of discounting. Each discount left the previous owners with a joint liability vis-á-vis the purchaser of the bill (the discounter). Each discounter signed the bill in an acknowledgement of his commitment to pay the bill in case of default by the drawee.

[17]It only required the ascertainment of the default on the payment in due time by a bailiff, a notary

relates to the cases where a guarantee was called, not to the share of bills to be written off. While the procedure could take a couple of weeks, ultimately losses were close to zero.

To limit the risk of losses the Bank of France applied strict rules (Jobst, 2010). First, the law required the Bank of France to discount only bills endorsed by at least three notoriously solvent persons. The third signature could have been replaced by pledging liquid securities like government bonds. Second, the bank screened its counterparties carefully through local discount committees which had good knowledge of the businesses of presenters of bills. The activity of the committee was in turn monitored by the portfolio committee composed of shareholders of the bank and ultimately examined by three censors elected by the shareholders assembly. In addition, inspectors visited local branch offices at least once a year. Those visits allowed them to assess the quality of the decision of the discount committee by crosschecking the information on presenters and endorsers and to check whether the director of the branch did not overstep his responsibilities by bypassing decisions of the local discount committee. Together these precautions explain why the Bank of France suffered less from non-payment than the average discounter in the economy. Also no correlation between the extension of discount loans in areas affected by phylloxera and losses on the discount portfolio can be discerned. The comparatively lower default rates in districts served by a branch office of the Bank of France can thus not be explained by an implicit subsidy or bail-out by the Bank of France of insolvent borrowers but was due to the liquidity support offered by the Bank of France branches.

7. Conclusion

The present article provides an empirical analysis of the beneficial effects of broad access to the central bank as lender of last resort. Our goal is quantitative. We use a quasi-natural experiment that occurred in France in the 19th century to document that broad eligibility criteria helped stabilizing economies hit by economic shocks. The empirical analysis is based on a newly assembled dataset tracing the economic evolution of all French districts during the period from 1826 to 1913.

or two witnesses at the moment the bills fell due and allowed the owner of the bill to invoke the guarantee of the last endorser, asking him to pay in lieu of the initial payer. If the first endorser also failed and the bill was endorsed by another person, the joint liability clause again applied, and so on up to the drawer of the bill.

To isolate a source of exogenous variation the identification strategy exploits the peculiarities created by a constraint on the implementation of monetary policy. In the 19th century the eligibility to the discount window of the Bank of France was directly conditioned on the existence of a local facility by the Bank allowing it to collect payments when due. This feature allows exploiting the spatial dimension of central bank access, as we can argue that the opening of branches by the central bank was exogenous to both to the various shocks and to the default rate.

To test for the consequences of access to central bank lending (or the absence thereof) on economic outcomes, we study a negative productivity shock triggered by an agricultural disease, phylloxera. Lower incomes by farmers translated into an income shock for firms in other sectors increasing the demand for credit by solvent firms to smooth the consequence of the agricultural crisis. As entrepreneurs had little incentive to strategically default, the main problem for the lender was to screen the solvency of the firms hit. By discounting, the central bank liquefied the wealth of private agents, i.e. transformed assets that could not be traded or only at a high cost into liquid banknotes or reserves that allowed borrowers to pay their bills. The paper shows not only that the increased volume of money distributed by the lender of last resort helped smooth the consequences of the crisis but that broad access to the central bank was particularly helpful. At the same time, the Bank of France did not bail out the private sector by taking over worthless assets.

The fact that the extension of eligibility via the creation of new branch offices was not driven by stress in the financial sector but caused by structural reasons also implies that the positive results of the extension of eligibility were not the result of an explicit policy by the bank. The argument however adds a new channel through which central bank branching might have affected the real economy. More generally, we think that eligibility of counterparties and assets deserves more attention. If there is any lesson to draw from this past experience in terms of today's monetary policy, our results stress the importance of the framework in which the central bank implements its monetary policy in times of crisis.

A. Appendix

French districts . In 1826 France was composed of 86 districts with a size equivalent to the average size of a U.S. county. Two main changes in the frontiers of France make the panel slightly unbalanced. First, in 1860 France incorporated three new districts with the annexation from Italy of the Savoy and Nice which brought the total number of districts to 89. The defeat in the war against Prussia in 1871 ended with the loss of two districts in Alsace and of half of the Meurthe district and half of the Moselle district. The remaining parts of the latter districts were merged to form a new district, Meurthe et Moselle. Part of the Alsatian district "Haut-Rhin" remained French in the post 1871 period, but was dropped from our sample. Hence after 1872 France contained 86 districts. The quality of the data during the war years of 1870 and 1871 led us to drop the observations for these years.

Population Data on population in each district were taken from Bignon, Caroli, and Galbiati (2016).

Wine production and phylloxera Data on wine come from Galet (1957). We use data collected by Banerjee et al. (2010) on the years during which phylloxera was spotted in each district and on the variables of wine cultivation and wine production.Galet (1957) provides no information on the presence of the phylloxera in two districts, the Ardéche and the Creuse. They were dropped from the regression analysis during the whole period.

District GDP in 1862 . We used Delafortrie and Morice (1959) to compute the share of wine production as a percentage of local GDP during the year just before phylloxera appeared.

Central banks and banks . Statistics on the activities of the Bank of France were taken from the annual report to the General Assembly of the Shareholders. A typical report indicated where the branches of the Bank were operated during the year and the volume of outright purchases done. The annual reports also reported data on protested bills at the national level. Information on the branch offices operated by the two most important national branch banks, Société Générale and Crédit Lyonnais, comes from Billoret (1969) and the annual reports of Société Générale.

Defaults of firms in the industrial and service sectors Few corrections were made to those data since the definition of the scope of firms that may default under the procedure *faillites* did not change during the 19th century, nor did the definition of the failure, i.e. the fact that the manager of a unit defaulted on his payment obligations. Yet some innovations introduced in the course of the century require some assumptions. The most notable change was the 1889 law that introduced a new process through which disputes over the payment of debt could be settled, the *liquidation judiciaire*. This new procedure was said to have been motivated by the intention to lower the failed debtor's shame and social stigma associated with filing for bankruptcy. Therefore a strict reading of the letter of the law would have led to exclude this procedure from the actual number of bankruptcies. But following the letter of the law would have also created a spurious decrease of the default rate, as a huge substitution occurred between the traditional failure procedures and the new one. Hence following all previous scholars, the failure numbers include for the 1889-1913 period both the number of *faillites* and the number of *liquidations judiciaires*.

The stock of operating firms in services and industry. Most previous scholars have used and commented the absolute number of defaults, without any correction for the potential increases in the number of firms operated (Jobert and Chevailler, 1986). We use a fiscal source (the *Patente*) to document the population of firms in services and industry. The firms eligible to the payment of this tax were also those that were eligible to the default procedure that we use to compute the default rate, as noted in the 1880s by the ministry of Justice in the introduction to the *Compte général de la justice civile et commerciale*. Loua (1877) and Limousin (1900) also used this tax to measure default rates. Corrections must be implemented to correct for the spurious changes created by a number of tax reforms that altered either its tax base or the population eligible to its payment. The *Patente* was a tax introduced in 1791 that survived the whole 19th century. It had to be paid by any type of businesses selling goods or services on the market. These included (among others) shopkeepers but also wholesalers, any type of factories, craftsmen and banking and insurance firms. The agricultural sector was exempted from paying it, as were the legal professions. Data on the number of *patentes* paid at the district level were collected in the national archives in the file F20 423 titled "*Ministéres des finances, relevés des contributions directes*" for the years 1826-1844 as kept by the National Archives in Paris. The data on the number of firms paying the tax for the years 1845 to 1872 and 1881, 1882 and 1889 are from the *Compte général des recettes de l'état* as kept in the National Library in Paris. The numbers for the years 1873 to 1899 and 1904-1911 -except 1881, 1882, 1889 to 1892 are taken from the statistical yearbook *Annuaire Statistique de la France* as kept in the online website gallica.bnf.fr. The number for years 1890 to 1892 and 1900 to 1903 are taken from "*Renseignements statistiques relatifs aux impôts directs*" that are kept in the Cujas library in Paris.

References

Armantier, Olivier, Eric Ghysels, Asani Sarkar, and Jeffrey Shrader. 2015. "Discount Window Stigma during the 2007-2008 Financial Crisis." *Journal of Financial Economics* 118 (2):317–335.

Bagehot, Walter. 1873. *Lombard Street: a description of the money market.* London: Henry S. King and Co, 5th edition ed.

Banerjee, Abhijit, Esther Duflo, Gilles Postel-Vinay, and Timothy M. Watts. 2010. "Long Run Health Impacts of Income Shocks: Wine and Phylloxera in 19th Century France." *Rev. Econ. Stat.* 92 (4):714–728.

Bazot, Guillaume. 2014. "Local liquidity constraints: What place for central bank regional policy? The French experience during the Belle Époque (18801913)." *Explorations in Economic History* 52:44–62.

Bignon, Vincent, Eve Caroli, and Roberto Galbiati. 2016. "Stealing to Survive? Crime and Income Shocks in 19th Century France." *Economic Journal* forthcoming.

Billoret, Jean-Louis. 1969. *Système bancaire et dynamique économique dans un pays à monnaie stable 1816-1914.* Ph.D. thesis, University of Nancy.

Bindseil, Ulrich and Juliusz Jerzy Jablecki. 2013. "Central bank liquidity provision, risk-taking and economic efficiency." Tech. rep., ECB working paper 203.

Bouvier, Jean. 1973. *Un siècle de banque Française.* Paris: Hachette littérature.

Bravard-Veyrières, M. and Ch. Demangeat. 1862. *Traité de droit commercial*, vol. III. Paris: Marescq Ainé, A.

Burdeau, M. 1892. *Rapport fait au nom de la commission chargée dexaminer le projet de loi et les propositions de M. Ferry et M. Dumay.* Documents parlementaires.

Cameron, Rondo. 1961. *France and the economic development of Europe 1800–1914.* Princeton: Princeton University Press.

Chamley, Christophe and Herakles Polemarchakis. 1984. "Assets, General Equilibrium and the Neutrality of Money." *Review of Economic Studies* 51 (1):129–138.

Chapman, James and Antoine Martin. 2013. "Rediscounting under Aggregate Risk with Moral Hazard." *Journal of Money, Credit and Banking* 45 (4):651–674.

Cúrdia, Vasco and Michael Woodford. 2011. "The central bank balance sheet as an instrument of monetary policy." *Journal of Monetary Economics* 58 (1):54–79.

Dalloz, Victor. 1830. *Traité des effets de commerce*. Paris: Tarlier.

Delafortrie, Nicole and Janine Morice. 1959. *Les revenus départementaux en 1864 et 1954*. Paris: Librairie Armand Colin.

Flannery, Mark J. 1996. "Financial crises, payment system problems, and discount window lending." *Journal of Money, Credit and Banking* 28 (4):804–824.

Freixas, Xavier, Jean-Charles Rochet, and Bruno M. Parigi. 2004. "The Lender of Last Resort: A Twenty-first Century approach." *Journal of the european economic association* 2 (6):1085–1115.

Gale, G. 2011. *Dying on the Vine. How Phylloxera Transformed Wine*. Berkeley: University of California Press.

Galet, Pierre. 1957. *Cépages et vignobles de France*. Montpellier: Imprimerie du Paysan du Midi.

Gertler, Mark and Nobuhiro Kiyotaki. 2010. *Handbook of Monetary Economics*, vol. 3A, chap. FInancial intermediation and credit policy in business cycle analysis. Amsterdam: Elsevier, 597–600.

Hoffman, Philip T., Gilles Postel-Vinay, and Jean-Laurent Rosenthal. 2015. "Entry, information, and financial development: A century of competition between French banks and notaries." *Explorations in Economic History* 55:39–57.

Hoffman, Philip T., Gilles Postel-Vinay, and Laurent Rosenthal. 2001. *Des marchés sans prix. Une économie politique du crédit à Paris, 1660–1870*. Paris: Editions de l'EHESS.

Jobert, Philippe and Jean-Claude Chevailler. 1986. "La démographie des entreprises francaises en France au 19ème siécle." *Economie et Sociëté* 2:233–264.

Jobst, Clemens. 2010. *Gouverner une banque centrale: du XVIIe siècle à nos jours*, chap. Gouverner une banque centrale décentralisée: lexemple austro-hongrois (1847-1914). Paris: Albin Michel, 113–142.

Kaufmann, Eugene. 1914. *La Banque en France*. M. Giard Editeurs.

Kiyotaki, Nobuhiro and John Moore. 2005. "Liquidity And Asset Prices." *International Economic Review* 46 (2):317–349.

Leclercq, Yves. 2010. *La Banque supérieure. La Banque de France de 1800 à 1914*. Bibliothèque de l'économiste. Paris: Classiques Garnier.

Lescure, Michel. 2003. *Politiques et pratiques des banques d'émission en Europe, XVIIe–XXe siècle*, chap. La formation d'un système de crédit en France et le rôle de la banque d'émission 1850–1914. Albin Michel, 131–148.

Limousin, Ch. M. 1900. "Philosophie de la statistique de faillite." *Journal de la Société de Statistique de Paris* 41:52–61.

Loua, Toussaint. 1877. "Les faillites." *Journal de la Société de statistique de Paris* 18:281–291.

Loubere, Leo. 1978. *The Red and the White: A History of Wine in France and Italy in the 19th century*. State University Of New York Press.

Millardet, Alexis. 1877. *La question des vignes américaines du point de vue théoqique et pratique*. Bordeaux: Féret et fils.

Nishimura, Shiyuza. 1995. "The French provincial banks, the Banque de France, and bill finance, 1890–1913." *Economic History Review* 48:536–554.

Percerou, Jean. 1935. *Faillites, banqueroute et liquidations judiciaires*. Paris: Rousseau.

Plessis, Alain. 1985. *Régents Et Gouverneurs de la Banque de France*. Genève: Librairie Droz.

Pose, Alfred. 1942. *La Monnaie et ses institutions, histoire, théorie et technique*. Paris: Presses Universitaires de France.

Postel-Vinay, Gilles. 1989. *Agrarian Organization in the Century of Industrialization: Europe, Russia, and North America*, chap. Debts and Agricultural Performance in the Languedocian Vineyard, 1870–1914. Greenwich (CT): JAI Press, 161–186.

Pouget, R. 1990. *Histoire de la lutte contre le phylloxéra de la vigne en France*. Paris: INRA.

Roulleau, Gaston. 1914. *Des r'eglements par effets de commerce en France et a l'etranger*. Paris: Imprimerie Dubreuil, Frérebeau et Cie.

Tate, William. 1868. *the modern cambist forming a manual of foreign exchanges in the different operations of bills of exchanges and bullion*. London: Effingham Wilson Royal Exchange.

Venkateswaran, Venky and Randall Wright. 2014. "Pledgability and Liquidity: A New Monetarist Model of Financial and Macroeconomic Activity." *NBER Macroeconomics Annual* 28 (1):227–270.

Wallace, Neil. 1981. "A Modigliani–Miller Theorem for Open–Market Operations." *American Economic Review* 71 (3):267–274.

Williamson, Stephen D. 2014. "Central Bank Purchases of Private Assets." Tech. Rep. 2014–026, working paper of the Saint Louis Fed.

Wolfers, Justin. 2006. "Did unilateral divorce laws raise divorce rates? a reconciliation and new results." *American Economic Review* 96 (5):1802–1820.

B. Tables

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Default rate	0.234	0.175	0	3.585	6880
Phylloxera spotted	0.014	0.053	0	0.545	6880
Phylloxera impactdummy	0.012	0.048	0	0.545	6880
Phylloxera impactvolume	0.005	0.027	0	0.41	6880
Number of BoF branches	0.728	0.764	0	9	6880
BoF branches per capita	0.002	0.002	0	0.01	6880
Deposit bank branches	1.701	3.008	0	36	6880
Deposit bank branches per capita	0.004	0.007	0	0.05	6880
Population density	126.684	586.320	15.081	8932.035	6880
Firm density	0.043	0.014	0.007	0.081	6880
Farmsize	4.571	2.807	0	11.391	6880

Table 2: Baseline estimations

	(1)	(2)	(3)	(4)
	Baseline	Additional controls	Wine intensive	1863-1890
	b/se	b/se	b/se	b/se
Shock	0.69***	1.21***	1.17***	0.72
	0.23	0.40	0.42	0.45
BdF branches	-0.02	-0.02	-0.02	0.00
	0.01	0.01	0.01	0.01
BdF*shock	-0.46***	-0.75**	-0.91**	-0.72**
	0.11	0.35	0.36	0.29
CL/SG		-0.00	-0.00	-0.00
		0.00	0.00	0.00
CL/SG*shock		0.13*	0.15*	0.07
		0.08	0.08	0.09
Population density		-0.00011***	0.00392	-0.00004
		0.00003	0.00352	0.00003
Firms per capita		-3.23**	-2.86*	-5.01
		1.36	1.61	3.23
Farmsize*shock		-0.082	-0.056	0.035
		0.063	0.064	0.063
R^2	0.546	0.549	0.733	0.400
Observations	6880	6880	3010	2080

All specifications include year and district fixed effects as well as district specific time trends. Residuals are clustered at the distric

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

Table 3: **Estimations with alternative measure for eligibility**

	(1)	(2)	(3)	(4)
	Baseline	**Controls**	**Wine intensive**	**1863-1890**
$Shock_{it}$: $impactvolume_{it}$	0.71***	1.00**	0.94**	0.50
	0.26	0.41	0.43	0.50
$Elig_{it}$: $Branchcapit_{it}$	-2.20	-1.94	-4.34	-0.00
	3.60	3.48	4.75	2.62
$Elig_{it} * Shock_{it}$	-199.35***	-209.80*	-255.38**	-208.01*
	61.44	118.51	123.86	114.05
Deposit bank branches per capita		-0.78	-0.21	-0.85
		1.34	1.65	1.90
Deposit bank branches p.c.*$Shock_{it}$		35.29	40.26	10.96
		30.81	30.06	35.81
Population density		-0.00012***	0.00329	-0.00005
		0.00003	0.00371	0.00003
Firms per capita		-3.10**	-2.71	-5.08
		1.38	1.70	3.29
Farmsize*$Shock_{it}$		-0.076	-0.055	0.050
		0.073	0.080	0.067
Fixed effects	yes	yes	yes	yes
R^2	0.545	0.548	0.731	0.399
Observations	6880	6880	3010	2080

* p<0.1, ** p<0.05, *** p<0.01; Standard errors in parentheses

All specifications include year and district fixed effects as well as district specific time trends.

All variables are yearly, residuals are clustered at the district level.

Table 4: **Alternative estimations with crisis variable measured by phylloxera being spotted in the district**

	(1) **Baseline**	(2) **Controls**	(3) **Wine intensive**	(4) **1863-1890**
$Shock_{it}$: $Spotted_{it}$	0.19	0.43*	0.47*	-0.03
	0.12	0.23	0.24	0.18
$Elig_{it}$: $Branches\#_{it}$	-0.02*	-0.01	-0.02	0.00
	0.01	0.01	0.01	0.01
$Elig_{it} * shock_{it}$	-0.16**	-0.38**	-0.47**	-0.33***
	0.06	0.17	0.18	0.09
Deposit bank branches #		-0.00	-0.00	-0.00
		0.00	0.00	0.00
Deposit bank branches*$shock_{it}$		0.06	0.08**	0.08*
		0.04	0.04	0.04
Population density		-0.00012***	0.00385	-0.00005
		0.00003	0.00339	0.00003
Firms per capita		-3.36**	-2.96*	-5.01
		1.37	1.63	3.33
Farmsize*shock		-0.016	-0.016	0.033
		0.024	0.023	0.023
Fixed effects	yes	yes	yes	yes
R^2	0.544	0.547	0.731	0.399
Observations	6880	6880	3010	2080

* p<0.1, ** p<0.05, *** p<0.01; Standard errors in parentheses

All specifications include year and district fixed effects as well as district specific time trends.

All variables are yearly, residuals are clustered at the district level.

Table 5: **Alternative estimation in which the crises are measured by variable** $impactdummy_{it}$

	(1)	(2)	(3)	(4)
	Baseline	**Controls**	**Wine intensive**	**1863-1890**
$Shock_{it}$: $impactdummy_{it}$	0.11	0.34*	0.39*	-0.11
	0.09	0.21	0.23	0.17
$Elig_{it}$: $Branches\#_{it}$	-0.02*	-0.02	-0.02	0.00
	0.01	0.01	0.01	0.01
$Elig_{it} * Shock_{it}$	-0.12**	-0.27*	-0.38**	-0.23***
	0.06	0.15	0.16	0.06
Deposit bank branches #		-0.00	-0.01	-0.00
		0.00	0.00	0.00
Deposit bank branches#*$Shock_{it}$		0.04	0.06*	0.07
		0.03	0.03	0.05
Population density		-0.00011***	0.00395	-0.00004
		0.00003	0.00339	0.00003
Firms per capita		-3.23**	-2.67	-4.46
		1.40	1.65	3.38
Farmsize*$Shock_{it}$		-0.018	-0.017	0.030
		0.019	0.020	0.025
Fixed effects	yes	yes	yes	yes
R^2	0.544	0.547	0.731	0.398
Observations	6880	6880	3010	2080

* p<0.1, ** p<0.05, *** p<0.01; Standard errors in parentheses

All specifications include year and district fixed effects as well as district specific time trends.

All variables are yearly, residuals are clustered at the district level.

Table 6: **Controlling for spatial autocorrelation of the error term**

	(1)	(2)	(3)	(4)	(5)	(6)
	Baseline	**Branch density**	**# branch**	**Spotted # branch**	**Controls**	**Controls**
$Shock_{it}$: $impactvolume_{it}$	0.68***	0.71***			1.21***	1.02**
	0.23	0.25			0.39	0.40
$Shock_{it}$: $impactdummy_{it}$			0.19			
			0.12			
$Shock_{it}$:$Spotted_{it}$				0.11		
				0.09		
$Elig_{it}$:$Branches\#_{it}$	-0.02*		-0.02*	-0.02*	-0.02*	
	0.01		0.01	0.01	0.01	
$Elig_{it}$:$Branchcapit\#_{it}$		-2.47				-2.21
		3.59				3.46
$Elig_{it} * Shock_{it}$	-0.456***	-200.113***	-0.159**	-0.121**	-0.744**	-211.187*
	0.113	59.381	0.063	0.054	0.338	115.801
Deposit banks					-0.00	
branches					0.00	
Branches deposit						-0.718
banks per capita						1.332
Deposit banks*$Shock_{it}$					0.13*	36.56
					0.07	29.88
Population density					-0.00011***	-0.00011***
					0.00003	0.00003
Firms					-3.299**	-3.174**
per capita					1.35442	1.376
Farmsize*$Shock_{it}$					-0.086	-0.0804
					0.061	0.072
Spatial	6.644**	6.817**	6.878**	6.946**	6.987*	7.126*
lambda	3.268	3.434	3.278	3.304	3.591	3.691
Variance	0.0086***	0.0087***	0.0087***	0.0087***	0.0086***	0.0086***
sigma2_e	0.003	0.0031	0.0031	0.0031	0.0031	0.003
r^2	0.021	0.020	0.021	0.021	0.100	0.105
Observations	6880	6880	6880	6880	6880	6880

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

All specifications include year and district fixed effects as well as district specific time trends;

All variables are yearly, residuals are clustered at the district level.

Table 7: **Endogeneity of BoF branching–1 year lag**

	(1)	(2)	(3)	(4)	(5)	(6)
	Default	**Default**	**Shock**	**Shock**	**Default+shock**	**Default+shock**
Default rate avg	0.00	2.56e+61			0.00	3.66e+61
Phylloxera			0.70	1.04	0.72	0.98
BoF present in district		0.00143***		0.00142***		0.00143***
Deposit bank city		4.82***		5.17***		4.81***
Capital city		4.99***		4.92***		4.98***
City pop		1.00		1.00		1.00
Pop rank = 1		1.00		1.00		1.00
Pop rank =2		0.55*		0.55*		0.55*
Pop rank =3		0.38**		0.39**		0.38**
Pop rank =4		0.09***		0.09***		0.09***
Pop rank =5		0.06***		0.06***		0.06***
District pop		1.000001***		1.000002***		1.000001***
District surface		1.00017*		1.00015		1.00017*
No. of subjects	1074	1054	1076	1059	1074	1054
No. of failures	86	80	88	82	86	80
Time at risk	50460	35088	50682	35268	50460	35088
Adj. R-Squared	0.00	0.37	0.00	0.37	0.00	0.37
LR chi2	0.202	392.235	0.624	400.815	0.742	392.236

Exponentiated coefficients. All variables lagged by 1 year.

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

Table 8: **Endogeneity of BoF branching–2 year lagged**

	(1)	(2)	(3)	(4)	(5)	(6)
	Default	**Default**	**Shock**	**Shock**	**Default+shock**	**Default+shock**
Default rate avg	0.00	2.56e+61			0.00	1.17e+60
Phylloxera			0.82	1.26	0.84	1.18
BoF present in district		0.00***		0.00***		0.00***
Deposit bank city		4.82***		5.29***		4.93***
Capital city		4.9853***		4.9191***		4.9864***
City pop		1.00		1.00		1.00
pop rank 1		1.00		1.00		1.00
pop rank 2		0.55*		0.55*		0.56*
pop rank 3		0.38**		0.38**		0.38**
pop rank 4		0.087080***		0.087507***		0.086875***
pop rank 5		0.06***		0.06***		0.06***
District pop		1.00***		1.00***		1.00***
District surface		1.00*		1.00		1.00*
No. of subjects	1074	1054	1076	1059	1074	1054
No. of failures	86	80	88	82	86	80
Time at risk	50460	35088	50682	35268	50460	35088
Adj. R-Squared	0.00	0.37	0.00	0.37	0.00	0.37
LR chi2	0.202	392.235	0.188	400.997	0.341	392.328

Exponentiated coefficients

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