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

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Abstract

This paper show that the central bank is more efficient in mitigating economic crises when it broadens the access to its lender of last resort facility to any safe asset or solvent agents. We use differences in differences panel regression and study the consequences of variations in the arrival of an agricultural disease on defaults of banks and firms of services and industry. We exploit peculiarities of 19th century central banking to overcome endogeneity of eligibility to the crisis and the default rate. We find that broad eligibility for the discount window has a statistically and economically significant impact on the reduction of local default rates when the negative income shock hurt the local economy. This effect is identified independently of changes in policy interest rates and fiscal deficit.

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

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1. Introduction

This paper studies the optimal design of a lender of last resort facility. It studies the benefit of allowing broad 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 allowed only a restricted subset of financial assets as collateral for the lending. Results show that the central bank stabilize 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 the intervention of central bank aimed at mitigating economic crises is an age–old controversy. But crisis time always features provisory extensions of eligibility to non-banks and to usually non-eligible assets. Quantitative evidence on the beneficial impact of those extension is limited. This paper fills this gap by showing that the central bank can and should intervene to mitigate crises by allowing the broadest access to its lending of last resort facility, provided agents are solvent and the collateral is safe. It can mitigate income shock independently of the implementation of any countercyclical fiscal policy or interest rate change by extending the eligibility for its lending of last resort facility, i.e. by widening the set of safe assets bought and/or by accepting more agents at the discount window. It should intervene because broadened eligibility rules can mitigate crisis *at no cost*, i.e. without any need to bail out (subsidize) the newly eligible sectors (distressed firms or banks).

The theory dealing with the real impact of eligibility rule has shown when variations in the composition of the asset side of the central bank balance sheet impacts on real allocations. Changes in the asset side of the central bank balance sheet matters when financial markets are segmented (Gertler and Kiyotaki, 2010, Cúrdia and Woodford, 2011) or when money is more liquid that the debt purchased by the central bank (Kiyotaki and Moore, 2005, Venkateswaran and Wright, 2014).[1]

We test whether the composition of the central bank balance sheet is neutral on economic outcome. Our empirical design allows studying whether a greater variety

[1] Wallace (1981) and Chamley and Polemarchakis (1984) established the irrelevance result stating that exchanging one debt (money) against another (e.g. government debt) leaves unchanged the real allocation if money does not provide transaction services. Recent research 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 (Williamson, 2014).

of safe assets held by the central bank allows to smooth the increase of the default rate of firms hit by an economic crisis, defined here as the defaults of firms of services and industry triggered by a negative productivity shock on the agricultural sector. The test of this hypothesis requires three ingredients. First an aggregate shock must trigger a non trivial increase of the demand for money (lending of last resort). Second many economies are differently exposed to this shock –some are more hit than others– but the shock does not hit all economies at the same time. Third monetary and fiscal policies do not differ among those economies but for the degree of eligibility to the discount window, i.e. except in terms of percentage of firms or assets that are allowed to collateralize lending of last resort loans. We claim that 19th century France has those three main ingredients. Our empirical strategy is as follows. To emulate economic crises, we study an income shock that hit the local economies at various point in time. To control for the other aspects of monetary policy, we work at the district (departement) level and exploit differences in the size of the income shock shock and in the degree of eligibility to the central bank to identify the effect. We annihilate the potential counter-cyclical impact of fiscal policy by working with an historical example in which the government refused to intervene.

Quantitative evidence of the beneficial impact of broad access to the lender of last resort is lacking, mostly because exogenous variations the asset side of the central bank balance sheet–i.e. changes in eligibility for the discount facility–are rare events. We claim that 19th c. France fulfills all the conditions of a quasi natural experiment to properly identify that the broadening of the access to the discount facility mitigated economic crises. Economic crises are emulated by the focus on the consequences on services and industry of a productivity and capital shock caused by an agricultural disease –the Phylloxera– that nearly killed the vines in an economy in which wine production was widespread (Banerjee, Duflo, Postel-Vinay, and Watts, 2010). This reduced wine production significantly. Neither the fiscal authority nor the central bank took any action to avoid the collapse of wine production. The productivity shock translated into an aggregate shock on local banking systems and the other sectors (Postel-Vinay, 1989). We exploit the variations in the arrival of this disease to identify the impact of income shock on defaults of banks and firms of services and industry. We exploit peculiarities of 19th century central banking to overcome endogeneity of eligibility to the income shock and the default rate.

Our analysis uses an uniquely rich administrative dataset on the number of defaults and on the stock of non-agricultural firms at the district level as recorded by the

ministry of justice and the finance ministry (respectively). We also have information at the district level on the volume of asset purchases by the central bank and on the eligibility rule. We include yearly data on more than 80 districts during the period from 1826 to 1913, of which 71.3% got infected,at one point in time, by the spread of the disease that occurred between 1863 and 1890. To our knowledge we are the first to exploit the default rate at the district level.

We run two types of panel regressions. First we show that an increase in the size of the local economic crises triggered by Phylloxera significantly increased the default rate of non-agricultural local firms, and of the volume of assets purchased by the central bank in the district. Second we run the following main regression with the default rate of non-agricultural local firms as the dependent variable and the following independent variable: the size of the local economic crises, a measure of the broadness of the eligibility for the central bank and an interacted term of the economic crises multiplied by the measure of the broadness of eligibility.

We show that districts with broader eligibility to the central bank experienced a lower increased of the default rate of firms of services and industry than districts with stricter eligibility rules when the income shock hurt the local economy. The results are robust across various specifications and to the correction of the spatial autocorrelation of the error terms. They are also robust to control for the importance of other national banks that did not have the right to issue banknotes but could also have mitigated the shock by increasing their discount activity. We further show that variations in eligibility at the district level were uncorrelated to the spread of the disease, to the size of the income shock or to the variations in (average of) the local default rate. We show that the profit of the central bank was unaffected by the massive purchases since a negligible proportion of the bills purchased by the bank of France were unpaid at maturity.

This paper contributes to the literature on the optimal central bank reaction to economic crises. A few papers in the literature exploit natural experiments to document the impact of an increase of central bank purchases on local economic activity (Richardson and Troost, 2009, Carlson, Mitchener, and Richardson, 2011). We document the positive impact of variations in the eligibility for the central bank lender of last resort operations. This paper also contributes to the literature in finance on the beneficial impact of recent eligibility extensions (Gu, 2012) and is the first exercise of this kind using historical data.

The rest of the paper is organized as follows. Section 2 discusses the conceptual

framework and presents our empirical strategy. Section 3 provides historical background on the financial and banking system of 19th century France and on the spread of the phylloxera pest. Section 4 presents the data sources. Section 6 discuss the results, the robustness check and present some counterfactual exercise. Section 7 concludes.

2. Conceptual Framework and empirical strategy

2.1. Conceptual Framework

The proposition that a broad set of eligible collateral or eligible agents to the central bank services helps to smooth income shocks is a long contention of theories of the lender of last resort (Bagehot, 1873). Those results are consistent with the view that the central bank is better able to stabilize an economy after a negative income show when it allowed a broad eligibility condition to its refinancing facility, i.e. when it imposes few restrictions on the types of agents who have access to the central bank and few restrictions on the types of safe assets that are bought or accepted as collateral by the central bank (Chapman and Martin, 2013).

The hypothesis tested in this paper is that economic crises are smoothed when agents are granted broad direct access to the lender of last resort facility compared to a situation in which they only got indirect access through a smaller number of agents in charge of redistributing the liquidity they received from the central bank. The argument rests on the existence of some positive (transaction) cost that added to the policy interest rate and that leads some agents to default despite them being solvent.

To test this hypothesis we study the consequence of an economic crisis that caused an unexpected increase of the demand for money that liquidity stressed traders used to repay their debt. If they cannot repay their debt, they have to default, which is costly for them and society since a defaulter cannot produce. Now the money demanded by distressed traders can be borrowed using a collateralized loan obtained either directly at the central bank or at one of the offices of deposit banks. The collateral is typically a claim against some illiquid capital (which amount to assume that the market for this capital is lacking) and the court enforce the transfer of ownership in case of default.

With perfectly competitive markets, the absence of frictions makes irrelevant the choice of the variety of assets that the central bank purchases against the money it

creates since an agent holding a non-eligible asset can trade it without cost against an eligible asset: Initial holdings do not impact on the situation of agents. But when trading is complicated by some friction, someone without enough eligible asset will pay a transaction cost that must be added to the interest rate paid by the agent to trade its (non-eligible) asset against the central bank money. We predict that if the transaction cost is high enough, the eligibility of the agents or of assets will matter on the efficiency of the economy. In this context broadening eligibility impacts the effective interest rate —defined as the sum of the CB interest rate and the transaction cost of obtaining the eligible asset— paid for central bank money.[2]

A number of mechanisms may explain why a restricted policy of eligibility may impact negatively the default rate. Harsh penalty in case of default and a big enough aggregate (negative) shock may trigger a substantial increase in the demand for eligible assets and hence of the effective price of accessing monetary assets. This could be the case in situation in which the working of the financial (interbank) market is impaired by adverse selection and difficulty to signal its true credit risk (Acharya et al. 2012; Heider, Hoerova and Holthausen, 2009). The relative scarcity of eligible assets to non-eligible assets may explain interest volatility on the secured money market (Heider and Hoerova, 2009). In any of those cases, the payment for the service of the intermediary consumes real resources that may force some agents to default on the repayment of their debt not because of insolvency but because of the cost of accessing the means of payment has temporarily increased. It is then possible to observe that a broadening of the eligibility rules of the central bank reduce the transaction cost to access central bank money, thus reducing the odds of default.

The only difference between the central bank and the deposit banks is that the central bank is the only agent allowed to issue banknotes. Deposit banks can only lend against their liquid wealth and a pool of demandable deposits collected from traders that are not liquidity-stressed. Issuing banknotes is free, but collecting demandable deposit is costly. If traders are not allowed to borrow directly from the central bank, the banks can still borrow from the central bank against their liquid wealth. In this situation we ask whether there the share of defaulting agents in this economy is lower is the central banks allowed a broad access to its discount facility compared to a

[2]This reasoning can be rephrased in terms of eligible agents, i.e. to the class of agents that enjoy direct access to the central bank. If only some part of the population has access to refinancing operations, those agents will act as intermediary in providing central bank money to the other part of the population, possibly against some collateral.

situation in which it lends to the banks that use this money to lend to the distressed traders. Holmström and Tirole (1998) show that the public authority should have been especially more effective in stabilizing crisis if the size of the aggregate was large enough.

2.2. Empirical strategy

Our goal is to determine whether variations of the proportion of eligible assets in a given class of debt contract had an impact on the variation of the default rate when the economy is hit by the phylloxera crisis. We estimate this relation using a difference-in-difference approach and pay special attention to the (potential) endogeneity of the eligibility choice to the income choice.

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 the firms operated 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 control are added to control for variations of the default rate in the district during the year $Controls_{it}$; see section 6 for details. All residuals are clustered at the district level.

The identification strategy allowing a proper testing of this hypothesis rests on six issues. First one needs to observe a crisis that hurt various economies at different points in time, and yet those economies varies in terms of the intensity of the crisis and in terms of the access of local traders to the discount window. Second the crisis needs to have a common cause in order to be reasonably sure that the observed variations in the increase of the local money demand are explained by the difference in the underlying cause of the crisis, i.e. the crisis has to be big enough to shift the local demand for the lending of last resort. Third, the crisis must ideally be caused by an exogenous event so as to exclude that the crisis originated in moral hazard behavior triggered by the expectation of eligibility extensions. Fourth to uniquely identify the role of the differences in the access to the discount window, one need a set of comparable regions that are exposed to the same monetary policy except for their

exposure to their eligibility to the central bank when the crisis occurs. But the degree to which agents and assets are eligible for the central bank varies independently from the size of the negative income shock or from the default rate.Fourth the central bank must lend on demand, so that we are reasonably sure that the severity of the crisis is not explained by a rationing of the quantity of money available in the economy. Finally one want to know whether the central bank has to record losses caused by this broaden eligibility policy, even years after the crisis was over.[3] Section 3 explains why the case under study fulfills all those requirements.

The spatial structure of the data might fuel concerns on 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 also correlated between nearby districts. Given the many possible but unobservable determinants of the default rate it is relatively likely that some explanatory variables were omitted, which potentially are spatially correlated. To test for the role of spatial correlation, we estimate the following model:

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

Which 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 the following Cox duration model, see section 6.3 for details.

[3] Together endogeneity, moral hazard and the taking-over of losses by the central bank after the crisis might bias the default rate upwards before the crisis and downwards after, leading to the wrong conclusion that the eligibility rule had the effect of mitigating the increase in the default rate.

3. Historical background

We first show how the peculiarities of 19th century French financial system allow addressing the empirical challenges associated with measuring exogenous variations in eligibility and then explain in section 3.2 why the phylloxera crisis allows to reasonably excluded the possibility that the crisis in the services and industry had been caused by moral hazard or the expectation of a bail-out.

3.1. Eligibility of assets to refinancing

In 19th century France, two main types of debt instrument were widely used to finance economic activity. Agents financed the acquisition of long-term asset with long-term (very) long term loans such as mortgages. Those loans were granted by wealthy persons (typically non-banks) to other non-bank agents. They origination was made by a special type of intermediaries who acts as matchmakers (Hoffman, Postel-Vinay, and Rosenthal, 2001). The second class of widely-used debt instrument was the bills of exchanges. The bills was the typical instrument used by banks. Bills of exchanges were a special class of guaranteed short term debt. In legal terms, a bill is an order to pay some amount of money to the bearer at some predetermined future date in some pre–specified location. Bills of exchange were negotiable. This means that they could have been guaranteed (discounted against a 'haircut') by a third party who could have resold them to a fourth party who also guarantee it, and so on. These bills were thus a tool of short-term finance between agents with excess liquidity (who were buyers of bills) and those with a need for short-term funding. Because the discount activity makes the discounter liable of the end payment in case of default, banks were the main discounters of bills.

The law required the owner of a bill to collect the payment of the bill at the debtor door. Financial intermediaries that held bills to maturity therefore had to set up an organization to collect payment 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. Because the technology did not change significantly during the whole century in terms of the collection of payments, the extension of the assets eligible for discounting was tied to the set up of local collection facilities by financial intermediaries, most importantly in the form of new branches. Therefore eligibility was restricted to assets payable in locations where the central bank (or deposit banks)

operated a branch. 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 the banks from opening them everywhere. This naturally creates variations in the local eligibility as soon as eligibility was not tied to the default rate or the occurrence of a crisis.[4]

The discounting of bills was potentially a risky activity that requires discounter to put "some skin in the game". Indeed holders of bills (the payee) were liable of the collection of the payment at maturity at the debtor's door. If the payee defaulted (was not ready to pay at maturity), the French jurisprudence on bills endowed the creditor with the right to immediately activate the guarantees associated with a bills of exchanges unpaid at maturity (Tate, 1868). This means that once the creditor had proven the inability of the payee to pay, he was immediately allowed to go to the guarantor's (endorsers) house to ask for the payment of the bills (Bravard-Veyrières and Demangeat, 1862). Default was harshly punished (Dalloz, 1830, Percerou, 1935). If creditors were not entirely reimbursed, creditors were not allowed to start and manage a new business. When creditors decided to allow the continuation of the business, and provided a debt restructuring was agreed upon, the defaulter did not recover his commercial and civil rights before the full completion of the reimbursement of the failed debts. This provides a huge incentive to traders to avoid strategic default.

The ability to activate the guarantee immediately made bills of exchanges a very safe and very liquid instrument. But it also may have triggered a wave of illiquidity-driven defaults since the commercial law force any type of debt to be in standstill before the majority of the creditors had agreed on an outcome of the default procedure (Percerou, 1935). Bills of exchanges did not benefit from an opt-out clause from the resolution procedure of failed firms, which means that creditors had to wait up until the end of the procedure to recuperate the proceed of their claim. Given that the average length of the procedure was between one and two years, and that creditors on average recuperated a significant percentage of their claim when the procedure ended, any exogenous increase in default likely 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 abound that when payment incidents started, it was difficult to prevent them because of the average duration of the procedure and the impossibility for creditors to exit or avoid the procedure before its legal termination.

[4]Notice that the central bank was forced to hold bills to maturity while other banks could always ask for the rediscounting of part of their holdings.

Two types of financial institutions could have helped the regional economies to smooth the consequences of economic crisis: either deposit banks with branches operated in various regions of the French territory or the central bank. Multi-branches deposit banks could have helped if they redistributed liquidity across the regions by granting loans to agents in distressed places using the deposits of those agents in locations free of the disease. Another possibility was the central bank issuing banknotes to finance distressed agents in plagued regions. Both types of banks used the same loan technology, i.e. they discounted short-term bills. An important difference was that the opportunity cost of their resources differed because the opportunity cost of the central bank must have been much smaller.

The discounter of last resort was the Bank of France, which was a publicly listed company endowed with the privilege of issuing banknotes. Its goal, according to its charter, was to refinance bankers and any other types of traders on demand. The bank paid dividend every semester to its private shareholders and was formally independent of the government. The main monetary policy decisions such as the volume of rediscounting or the level of the discount rate were decided by a governing body in which private shareholders had a two-third majority over the representatives of the government (Plessis, 1985).

The central bank purchased bills of exchange outright, and was restricted by its incorporation law to buy bills of maturing within the three months that followed the purchase.[5] The bank of France did not buy bills on a market, with open-market operations. It rather stand ready to purchase them on demand in its offices from agents in need for cash. The bank charged a price for this service by subtracting from the nominal of the bills the discount rate weighted by the residual maturity. The discount rate was set by the bank governing body. The discount rate could not be adjusted to local conditions or the specificities of the counterparties.[6]

The central bank was allowed to vary its eligibility policy with its judgment on the good standing of the traders. The law restrict eligibility to firms specialized in either services and industry and no bills payable by a farmer could have been discounted

[5]Banknotes could also be obtained through lending collateralized by the agents pledging some of the publicly traded securities, that were named advances against precious metal or securities such as railways or government securities. Because discounting represented an average 91% of central bank operations during the 1826-1913 period, we focus the discussion on discounting for the sake of simplicity but the argument will not be impacted if one consider the collateralized lending facility.

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

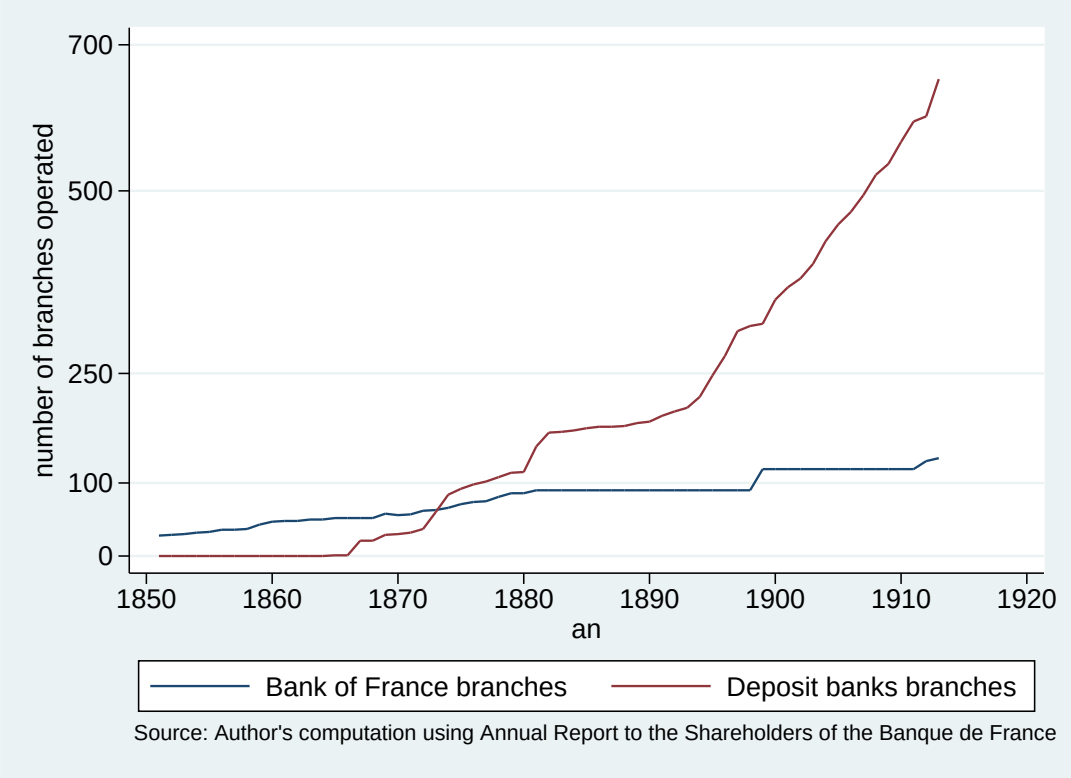


Figure 1: Number of branches operated by the bank of France and the two main deposit banks, 1850–1913

by the bank of France. The bank of France could also deny eligibility to bad-quality assets but because it could not adjust its discount rate to local conditions, it could not vary its haircut policy across districts and could neither varied it on the quality of the eligible assets or firms. Because bills were held to maturity, the central bank was only willing to accept bills payable in places in which it could actually claim the payment without having to pay another intermediary. This required either the payee to keep an account with the Banque de France or an officer of the bank had to be sent and collect the payment. In both cases the bank had to be physically present. It follows that only bills payable in a city in which the bank of France operated a branch were eligibility for its discount window. It follows that the share of local traders eligible to the central bank varied across districts because of a technological constraint created by the specificity of discounting activity.

Purchases of bills were made in each branch operated by the bank. The branches

opened gradually starting in the 1830s and spread evenly over the whole French territory. As long as the only office of the bank was in Paris, between the fall of Napoleon and 1836, that meant that that only bills payable in Paris were eligible to be discounted by the bank. 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 proportion of assets —among the set of existing eligible 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. The number of branches operated in each district varies between 1 (in most agricultural district) and 8 (in the district "Nord"). Because quite all branches opened in a city where none were operated before, it also shows the geographical extension of the branch network. This implies that the number of eligible counterparties rose significantly and that an increasing share of bills became acceptable for central bank rediscounting. We use this peculiar design of the access to the central bank to compare the impact of income shocks for regions that only differed with respect to their access to the central bank and use measure of the density of central bank branches to define varying level of exposures to the discount facility. Section 6.3 presents the policy of branch opening by the bank of France and shows that the bank of France did not vary its eligibility policy with the arrival of the income shock or the level of the default rate.

Starting in the 1860s, deposit banks developed extensive networks of branches (see figure 1) , with the aim of collecting deposits and of discounting bills of exchanges. Most deposit banks operated an internal capital market on which branches located in liquidity-stressed district could borrow the funds necessary to discount bills. The deposit banks operated the screening of discountable bills using local discount committee and were thus, as discussed extensively in the literature potential competitor of the bank of France in the discount activity (Bouvier, 1973).

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

We emulate economic crises by studying the adverse consequence on defaults in services and industry caused by the arrival of an agricultural disease in economies in which agriculture was an important source of income. Once it arrives in a district, the disease started destroying the vineyard, therefore reducing local wine production and making wine growers poorer (Banerjee et al., 2010, Bignon, Caroli, and Galbiati,

2015).

The disease was caused by the aphid *Phylloxera Vastatrix* –literally the killer of vineyard. It spread gradually onto the French territory and each district was not exposed equally since districts varied in their suitability to the wine-growing activity. The phylloxera is a near microscopic insect that started to affect French vineyards in 1863 (Gale, 2011, p. 18). The yellow aphid sinks its pointed snout into the roots and sucks out the sap. Its saliva infects the root at the attacked points preventing the wound from healing. This way the phylloxera not only causes the yield to fall to zero but kills the plants themselves in a short time. The approximate time between the arrival of the pest and the death of the plant is about a year (Pouget, 1990). The aphid spread gradually over the territory, though its speed of destruction was not uniform across time and space. For example between 1871 and 1879 the Gard lost 83% of its vineyards while the neighbouring Hérault lost only 59% (Lachiver, 1988, p. 416).

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 shows the geographic spread of the disease in 1871 and 1877. Yet 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 identified as linked to the symptoms in 1868, after the study of a dead vineyard near the Rhône by the botany professor Jules E. Planchon. After that identification, the scientific debate raged during seven years before the scientific community agreed that the bug was the cause and not just a consequence of the disease. Academics tried various treatments to fight the pest but none of those trials proved helpful for winegrowers (Pouget, 1990). It is only in 1890 that the cure to the epidemic 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, wine production represented 6.4% of the pre-aphid 1862 GDP. In 1890 the revenues from wine production had dropped to 2.75% of French GDP, see Figure **??**. In 1870 wine represents a source of income for 21% of the population (Millardet, 1877, p. 82). Price increases did not compensate for the fall in quantity (Banerjee et al., 2010, Bignon, Caroli, and Galbiati, 2015) and the impact of the aphid onto the local economy were sometimes disastrous (Postel-Vinay, 1989). However, its impact varied a lot across districts, as some of them did not grow any vines while in others wine production could reach up to 54% of the local GDP. Wine

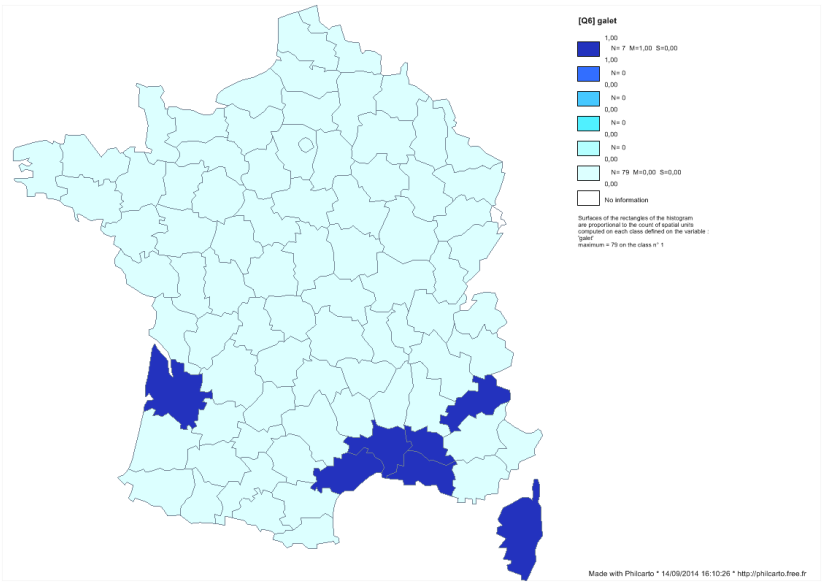


Figure 2: Districts infected by the phylloxera in 1871

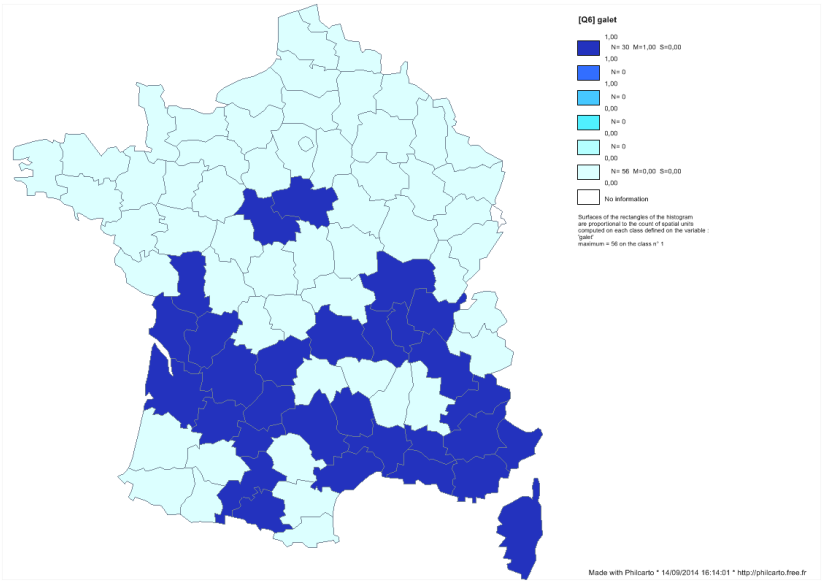


Figure 3: Districts infected by the phylloxera in 1877

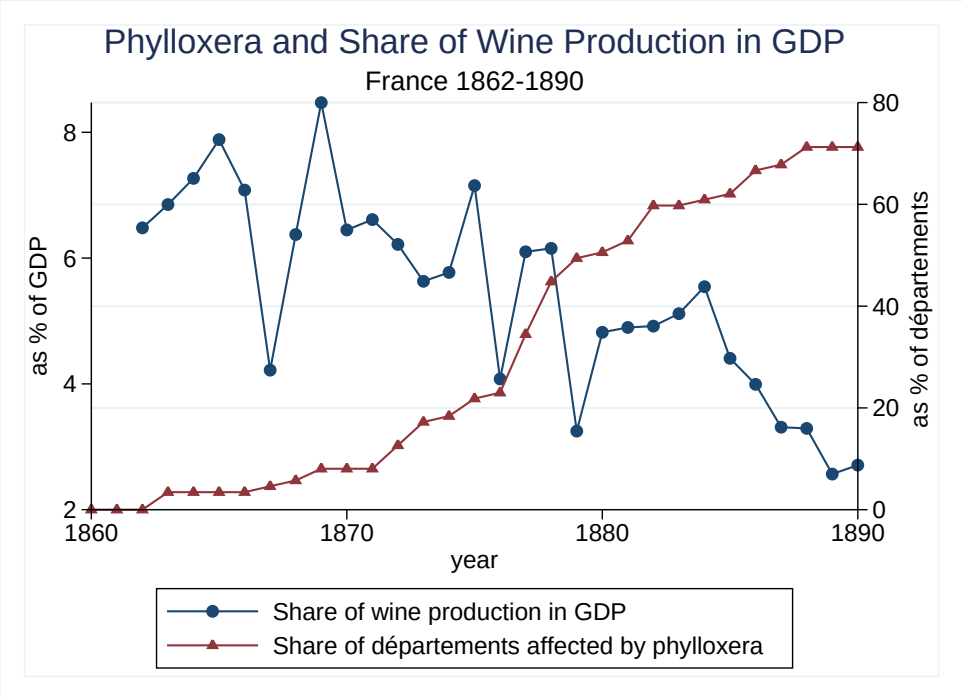
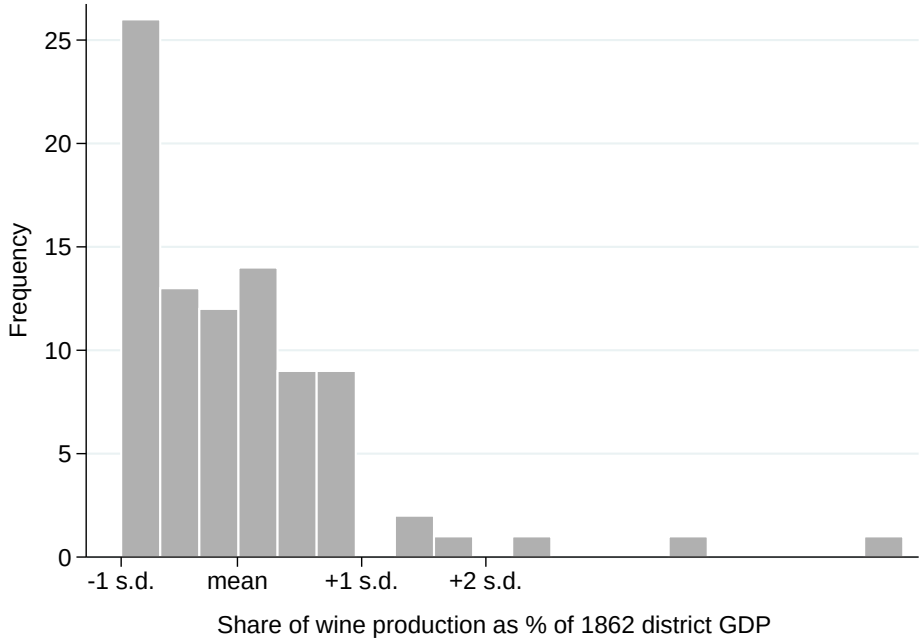


Figure 4: Revenues from wine production and the share of wine-producing districts infected by phylloxera between 1860 and 1890 (source: Bignon, Caroli and Galbiati, 2015)

production represented 9.2% of wine producing districts GDP. Figure 5 shows the distribution of the shares of wine production in percentage of the district GDP in 1862.

The shock induced by phylloxera did not impact consumers budget markedly. Indeed the increase of the farm gate price of wine was not accompanied by an increase in the consumption price. The price of wine in Paris was pretty stable during the whole period. Three main reasons explain this stability of consumer price. 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. The second wines (called *piquette*) made by adding sugar to the cakes that remained after the first pressing were sold on the market in the 1880s.

The impact of this huge shock on the agricultural sector was smoothed neither by fiscal nor monetary policy. The central bank was prohibited from lending against



Source: Author's computation using Delafortrie and Morice (1959) and Galet (1957)

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

any assets that had been originated in the agricultural sector. Fiscal policy was of little help: the state spent 1 million Francs a year on phylloxera at the apex of the disease in the 1880s and this money was directed toward scientific research Loubere (1978, p. 172). Moreover no welfare program such as unemployment benefits existed to smooth the revenues losses Bignon, Caroli, and Galbiati (2015). The shock created by phylloxera on the French economy was transmitted to the other sectors of the economy. This transmission should have decreased the other sectors revenues.

The length of the episode (from 1863 to 1890) made it impossible for farmers to maintain their consumption by drawing on their savings. It is also very unlikely that farmers were able to increase their saving in advance of the income shock. This would have required a clear understanding of how the disease spread and of its cause, an issue that was not settled before 1875 (Gale, 2011, chapter 1). Yet the final 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 of future losses. The literature identifies two reasons for this. Some argued that the disease would be confined by nature to some regions, while other simply denied its existence, arguing that the disease could

be avoid 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 mean to safeguard those still intact.

To sum up, phylloxera has several important advantages for the question at hand. (i) It allows circumventing the small sample problem typical of lending of last resort studies by emulating the adverse impact of financial crises on the rest of the economy ; (ii) The size of the shock had a discernable impact on the other sectors of the economy. (iii) The phylloxera was a real shock to the productive capacity of the agricultural sector, and hence our result cannot be driven by changes in expectations alone. (iv) The shock hit a sector that had no access to the facilities supplied by the central bank, thus ruling out that our results come from a differential implementation of monetary policy across the various districts. (v) The shock was independent of the action of any of the agents of the economy, thus ruling out that their past actions caused the shock. (vi) To banks, services and industry, the shock was as close as possible to a pure temporary (income) shock. (vii) The shock spread gradually over the territory, thus ruling out confounding factors created by simultaneous income shock.

4. Data

The dataset contains yearly observations on the default rate (Section 4.1, yearly measure of the importance of the shock triggered by the spread of the phylloxera in each district (Section 4.2) and measure of eligibility rule to the central bank and the two main deposit banks (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 the judicial procedure called failure (*faillites* in French). According to both law and jurisprudence this procedure aimed at protecting the equality of the 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 effectiveness of the liabilities (so as to avoid some creditors to be spoilt by made-up claims) and to decide on whether the business must be discontinued (in which case the monetary value of the assets was shared between the creditors) or whether the

firm had to continue in operation.[7]

The definition of a *faillite* in French law has a number of convenient features for our empirical design. The opening of a *faillite* procedure was tied to illiquidity and not to insolvency. Indeed the law decided that a failure procedure could be opened only after the observable recognition of a default. This was to avoid anti-competitive or political interferences with the existence of businesses, whereby some competitors could have argued in favour of the opening of a failure procedure only to drive a competitor out of business. In their comments of the law, legal scholars made it clear that the state of insolvency in itself cannot 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 . As a consequence no judge can force an insolvent but liquid firm to file for a failure procedure (Percerou, 1935). The law decided for a criterium not easily manipulated by outside parties concerned, and this provide one identifying assumption between default and the number of failure procedures opened in a given location during a given year.

The number of new failure procedure is the appropriate measure of default of services and industry. Indeed not all businesses or agents were allowed to file for the failure procedure. Only traders qualified for the procedure, while workers and other non-traders were excluded as well as farmers. Traders —*commercants* in its legal definition— could easily have been defined and the frontiers between activities was easily drawn. A trader was defined as an independent business earning revenues from the selling for profit of products and/or services.[8]Workers or firms the agricultural sector —farmers— were allowed to default under a different procedure. This 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 on the other sectors of the economy.

The number of defaults per district is known by counting the number *faillites* opened during a year. The data appendix details the sources used to document them at the district level. It is worth noticing that neither the definition, nor the collect of

[7]The creditors were assisted by a judge who has 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 decide to opt out of the procedure before the creditors vote on the outcome of the procedure except by renouncing to his claim.

[8]Examples included independent business such as wholesaler, shopkeeper, trader, insurer, banker or manufacturer.

the number of defaults counted as a failure by the ministry and the scope of businesses to which the law applied changed during the 19th century. To compute default rate, we compare the number of such defaults with the stock of firms in services and industry that were active during each year in each district. The number of firms of services and industry is know from the statistics on the French business tax (*patentes*). This tax was paid by every trader, i.e. any business selling goods or services for profit on the market, which encompass all shopkeepers, wholesalers, factories, craftsmen, and banking and insurance firms. The agricultural sector was exempted from its payment. 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. Appendix details the sources from which those tax-payers were retrieved.

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

A year before the phylloxera aphid was first spotted in the *Gard* district in 1863, wine was produced in 79 out of the 89 French districts.[9] The share of wine in agricultural production was then greater than 15% in 40 districts. The only non wine producing districts were located in the Normandy and the North of France. All the others produced at least some wine. Data on wine come from Galet (1957).

The shock of the phylloxera disease on the other sectors of the local economy varied with the share of wine in the district GDP. We use (Delafortrie and Morice, 1959) to compute the share of wine production as a percentage of the local GDP during the year just before the phylloxera appeared. We use data collected by Banerjee et al. (2010) on the years of presence of the phylloxera in each district and on the variables of wine cultivation and wine production.

$Phylloxera_{it}$ measures the impact of the shock created by the bug on the economy of district i during year t. Its size is the product of an indicator of the presence of the phylloxera in the district with the share of the wine production in the local GDP in 1862. The time it took for the bug to spread into each district varied across districts and time. Hence no single lag structure can account for it. This uncertainty leads us to use three alternative variables to measure the size of the shock induced by

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

phylloxera. All variable are weighted by the size of wine production in the district GDP in the pre-aphid year 1862.

The first variable is labelled $presence_{it}$. It is equal to the product of the share of wine in the 1862 GDP with the dummy $Galet_{it}$ 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 indicator to 0. The second variable is labelled $shock_{it}$. It is the product of the share of wine in the 1862 GDP with the dummy variable constructed by Banerjee et al. (2010). This dummy is set to 1 if the two following conditions are fulfilled. First the aphid is present in the district (the indicator *Galet* is equal to 1) and second wine production had fallen below its pre-phylloxera level (i.e. below the level it had reached during the last year before *Galet* =1). This indicator is set to 0 if *Galet* is equal to 0 and after the implementation of an effective treatment (i.e. after 1890). This variable takes into account the fact that it took time for the aphid to destroy the vineyards, though no information is available on the spread of the aphid within each district.

The third variable is labelled $weightedshock_{it}$. It is constructed by multiplying the variable $shock_{it}$ with the size of the loss of wine production caused by the phylloxera. Banerjee et al. (2010) constructed it by comparing the actual level of production with the one reached during the last year before the phylloxera was spotted in a district.

4.3. Eligiblity measure for the lender of last resort

To measure the extent of access of local agents to Bank of France or deposit banks lending, we use two different measures. The first is labelled *branches#* because it simply uses the number of branches operated by the two types of banks within each district. The other measure is labelled *branchescap* as it adjusts the number of branches for the population of the district, in case more densely populated districts with more cities needed more branches to offer the same degree of access to the banking system.[10]

Statistics on the activities of the central bank were taken from the annual report to the General Assembly of the Shareholders. A typical report indicated whether a branch of the bank was active or not during the year. It also provides the volume of business for every branch office and gives data on protested bills. Data on the

[10]Data on population in each district were taken from Bignon, Caroli, and Galbiati (2015).

branch network of the two most important national branch banks, Société Générale and Crédit Lyonnais, comes from Billoret (1969) and the annual reports of Société Générale.

5. Accounting for the spread of the phylloxera

We use the data on the years when phylloxera was present in each district as well as the data on wine cultivation and wine production. When defining the shock variable two dimensions have to be considered: (1) When did phylloxera arrive and (2) how severe was the shock. While the year when phylloxera was first spotted in each district is well known (Galet, 1957), the time it took the aphid to spread over the district is not so. Historians have noted that it took a long time for the aphid to destroy a significant proportion of the vineyards in the district and thus to potentially affect the other sectors of the economy. In addition, historical evidence indicates that the time until the aphid had spread to a significant part of the territory varied considerably across districts. Some insights on the length of the process can be obtained by running the following regressions along the lines of Wolfers (2006) that allows for a different impact of the phylloxera in different years:

$$Logprod_vin_{it} = \alpha + \sum_{i \geq 1} \alpha_i Infect_i + \epsilon_{it}. \tag{3}$$

where $Logprod_vin_{it}$ is the logarithm of wine production in hectolitres in district i and year t. $Infect\{i$ varies with the year of infection of a district by the phylloxera. $Infect1$ is set to 1 in the first year after the arrival of phylloxera in the district, $Infect2$ in the second year and so on. Therefore i takes value between 1 and (at most for the district contaminated in 1863) 27. To account 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 among districts. Finally, residuals are clustered at the district level, i.e. all regressions allow for correlation among the observations of a given district. As is well evident from figure 6, phylloxera started to have a significant negative effect on wine production two years after the first sighting of the aphid.

A more formal test of the relationship between the spread of the phylloxera and the economy is given by the study of the impact of the phylloxera on the default rate

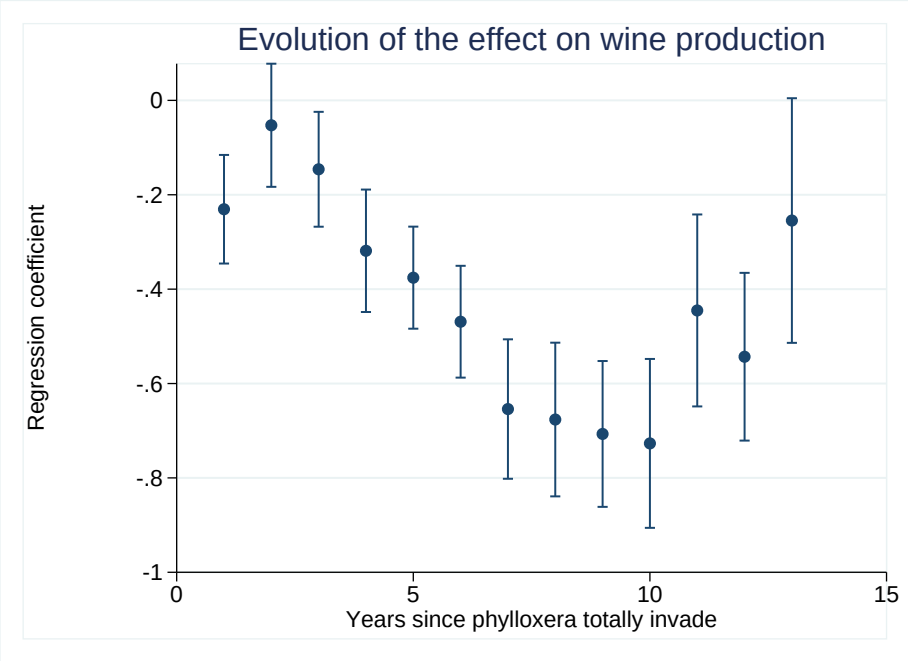


Figure 6: Dynamic effect of the spread of the phylloxera on wine production, 1850–1913 (source: Bignon, Caroli and Galbiati, 2015)

in the districts hit by the phylloxera. As outlined above, one of the advantages of using the default rate is that it does not include farmers or any other agricultural firms. Hence the dependant variable is a pure measure of the indirect impact of the shock on the local economy restricted to the services and industrial sectors. We therefore check that the productivity shock on agriculture trigger default in service and industry by estimating the following equations in which residuals are clustered at the district level.

$$DR_{it} = \delta_t + \alpha_i + \delta_t \cdot \alpha_i + \beta \cdot Shock_{it} + \epsilon_{it}$$

All the residuals are clustered at the district level. The results show that the shock created by the phylloxera increased significantly the default rate of firms of the services and industry, with the only exception being for the variable $Presence_{ij}$. One explanation for this non-significance is the fact this variable considers that the phylloxera shocked the district economy right from its arrival in the first vineyard, which, given the history of the spread of the aphid is clearly a very strong assumption. Historians noted that it takes some time for the aphid to destroy a significant

proportion of the vineyards of a district. Overall our results are consistent with our claim that, once the aphid spread in a district, the absence of a proper and sufficiently cheap treatment to prevent the vines from dying constituted a negative shock to the productive assets of farmers that was transmitted to the other sectors.

In line with our argument about the link between the phylloxera induced income shock and defaults in the non-agricultural sectors, a similar time lag can be observed when repeating this exercise with the default rate instead of the wine production as dependent variable:

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

where DR_{it} is the default rate in district i and year t and the other variables defined as in the regression above. The results show a similar lag structure as for the impact of phylloxera on wine production.

While these results indicate that the shock variable should preferably take account of some lag, the variance across districts prevents the use of a single lag structure. This uncertainty leads us to use two alternative specifications for dating the arrival of the shock. The first dummy, which we call *presence*, is set equal 1 from the first sighting of phylloxera until 1890, when a reliable treatment of phylloxera was found. The second, called *decline*, combines the sighting of phylloxera with a fall in wine production. This dummy is set equal 1 if first the aphid is present in the district and second wine production has declined below the level it had reached in the last year before the district was infected with phylloxera. As in the case of the first dummy, the dummy reverts to zero after 1890.

The second dimension of the shock is its severity. The impact of the shock will clearly vary with the importance of wine production for the local economies. To obtain the final versions for our shock variables we therefore multiply *presence* and *decline* with the share of wine in district GDP in the year before the arrival of phylloxera. Last but not least we add another shock variable, which we call $Wdecline$. It is a variant of *decline* but takes account of the actual percentage decline in wine production in district i during year t. The logic behind this variable is the possibility that due to geographical factors or different variants of vines, the wine production in some districts was more affected by phylloxera than in others. The variable is constructed by multiplying the variable decline by the percentage loss in production relative to the last year before the arrival of phylloxera.[11] Unlike the values of presence and

[11] We follow here again Banerjee et al. (2010). If in a given year the wine production is higher

decline the values of *Wdecline* thus vary from year to year in response to the fall in production induced by phylloxera. As *Wdecline* arguably takes best account of the way phylloxera spread within each district and affected wine production and local income, this is our preferred specification. The other two specifications will be used to check the robustness of the results.

6. Results

We first present the main results (section 6.1), before turning to some robustness check (section 6.2) and discussing the exogeneity of the eligibility measure to the default rate and the phylloxera spread (section 6.3.

6.1. Main results

The results of estimating equation (1) are reported in table 1 that gives our preferred specification using *Wdecline* as shock variable and the number of branch offices operated in the district as the measure for eligibility. As expected, the shock variable always enters with a positive sign, meaning that phylloxera increased defaults in the non-agricultural sector. The positive coefficient is also highly statistically significant in the two specifications that use *Wdecline* as the shock measure, while in the two specifications using *decline* and *presence* the coefficient it is not or only less so, depending on whether further controls were added. This confirms our hypothesis that *Wdecline* that takes into account both the lag in the spreading of phylloxera as well as differences in the impact on local wine production is the most adequate shock measure. The coefficient on access to the central bank, either measured by the number of branches or branch density, is always zero or negative and insignificant. However, there is no reason to expect any particular relationship between branches and the evolution of the overall default rate. The key variable of interest is the interaction between the shock and access to the central bank. If better access to the central bank successfully mitigated the negative effects of phylloxera, the interaction term should be negative, implying a lower default rate than if access to the central bank was unavailable or less well developed. As can be seen in the first column of table 1 the interaction term in the baseline without additional controls is always negative, and in all cases strongly statistically significant. This means that access to the

than in the year before the arrival of phylloxera, the variable is set to zero.

central bank prevented to some extent the agricultural crisis to spill over to solvent but liquidity constrained firms in the rest of the economy. Adding further controls does not alter the result. The number of firms per 1000 inhabitants and population density both capture local economic development and differences in the evolution of economic structures between 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 always negative and statistically significant, implying that higher developed districts featuring more entrepreneurial activity were also those with lower default rates, ceteris paribus. The variable farmsize*shock was included to account 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. Reasons might be that smaller farms have less outside resources available or –on the contrary–that smaller farms are better diversified. In any case, the coefficient is never statistically significant. Finally, we control for the branch networks of commercial banks. Starting in the 1860s commercial banks, most notably Crédit Lyonnais and Société Générale, created extensive branch networks that covered the entire territory of France. It could be argued that these networks could redistribute liquidity to districts hit by a liquidity shock in a similar manner as branches of the Bank of France. This possibility is not borne out by the regression results. The coefficients on the interaction term between commercial bank branches and the shock variable has the wrong sign and is not significant. The inclusion of additional control variables leaves the sign of the key variable of interest, the interaction term between the shock and eligibility, unchanged and does so for all combinations of possible measures for the shock and eligibility. Typically the absolute value of the coefficient on the interaction term increases, implying that the role of the central bank for alleviating the phylloxera shock is more important when more control variables are considered. The level of statistically significance of the interaction term is only marginally affected. Overall, therefore, the central hypothesis that better access to the central bank mitigated the impact of phylloxera on non-agricultural defaults holds up in a broad set of different specifications.

6.2. Robustness checks

Columns 3 and 4 in tables 1–4 provide estimates for two different sub-samples.

Restriction to wine-intensive districts only. Columns 3 exclude 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, which is true for 40 of the total 80 districts. Estimating the full equation for the sample with wine intensive districts only again leaves the main results unchanged. In three of the four specifications population density and firms per capita, both used as controls for economic development, are no longer significant. A reason might be that in the reduced sample including mainly agricultural districts these two variables no longer capture structural differences between the districts. More crucially, the coefficient on the shock variable and the interaction term do not change and their level of significance remains unaffected or even increases somewhat. **Explanation.**

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. **Explanation.** The results of this specification, reported in columns 4 show again no changes in the magnitude and statistical significance of the key variable, the interaction term between the shock and eligibility.

Alternative measures of the shock and eligibility variables. Tables 1–4 use alternative specifications for the shock and the eligibility variable. The results are unaffected by the change in the definition.

Spatial autocorrelation. A second set of robustness checks concerns potential spatial correlation. So far, all models have allowed for correlation among the observations of any given district by clustering residuals at the district level. Results are reported in Table 5. As the additional controls in tables 1–4 matter only marginally but raise computational challenges because of the large number of interaction terms, we focus here on the baseline specifications and include the additional controls only when estimating the model with $Wdecline$ as shock variable. As can be seen in all specifications reported in table 5 the spatial lambda is statistically significantly different from zero, which means that there is effectively spatial correlation in the error term. The inclusion of a spatial error term does however 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 a spatial error term in tables 1–4 shows that most coefficients and standard errors remain in fact

completely unchanged. Spatial correlation, while present, has thus no bearing on the results presented above.

6.3. On the exogeneity of branching to default rates and phylloxera

A last issue that might bias the estimation of equation 1 and 2 is the possible endogeneity of some of the explanatory variables to the dependent variable, the default rate. While the arrival and the spreading of phylloxera (the shock variable) is clearly unrelated to defaults in the non-agricultural sector, the same need not be true of the decision of the Bank of France to open new branch offices (the eligibility variable). In fact it might have been the case that the Bank opened new branches in order to alleviate the effects of phylloxera or, to the contrary, that the Bank hesitated to engage itself in districts hit by the economic crisis caused by phylloxera. As a result the estimated coefficient might over- or understate the true impact of access to the Bank of France on the default rate. This section provides narrative and econometric evidence that branching was not influenced by phylloxera and that the coefficient reported above are unbiased. Historians explain the gradual extension of the branch network of the Bank of France as the outcome of both political and competitive pressures (Pose, 1942, Bouvier, 1973, Plessis, 1985).

Competitive pressure built on the fact that the charter of the bank only granted it a monopoly of banknote issuance in the cities in which it operated a branch. With the end of the Napoleonic empire, the bank decided to close all the branches it operated outside Paris, finding them unprofitable and difficult to monitor. This motivates local political and trade elites in the provinces to lobby the government for the opening of independent bank of note issuance with monopoly right in the city (Gille, 1959). Nine cities succeeded in securing the privilege of a bank charter for their city, three in 1817 and 1818 and six other in the second half of the 1830s.[12] However the Banque de France –which had to be consulted on any incorporation of banks– succeeded in preventing the incorporation of nine other issuing banks (Cameron, 1967, p. 125) and creates fifteen branches between 1840 and 1848, each in a different city. The 1848

[12]The cities where a bank of issue was opened were: Bordeaux (1818), Nantes (1818), Rouen (1819), Marseilles and Lyons (1835), Lille (1836), Le Havre (1837), Toulouse and Orléans (1838) Marseilles (1840), see Kindlerberger (1993, p. 105-6). Gille (1970) provides an account of the motives for the creation of four of those banks together with the demise of the proposal made by Dijon traders.

financial crisis resulted in the taking over of independent banks of issue by the bank of France. Although competition was temporarily suppressed (Ramon, 1929, p. 230), it soon reappeared in the 1860s with the failed contest of the monopoly by the Pereires brothers (Cameron, 1961, 138–144).

In addition, the opening of a branch was costly. In the 1890s the Bank estimated those costs to be about 160,000 Francs, and the annual operating costs at 36,000 Francs for a small branch, at a time when the hourly wage of a qualified blue collar 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. As soon as a positive decision was taken, the Bank had to find a building and recruit director and staff as well as find the members of the committee that examined the bills submitted (comité de censure) be nominated. As a result the opening of a branch office typically required a lead time of one year and could not be used to address an acute crisis.

Nevertheless the network continued to expand, gradually until the mid-1880s and then in two jumps after 1897 and 1911 (see figure 1). Two forces were responsible for this extension. First, the protection of the charter did not prevent from competitive threats created by the development of national deposit banks Pose (1942) on the profit made on the discounting of bills of exchanges. Beginning in the 1860s some commercial banks, most notably Société Générale and Crédit Lyonnais, started to create their own large networks, soon covering the entire territory of France (Bouvier, 1973). 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 reacted by refinancing smaller regional and local banks in more remote places (Nishimura, 1995). A second reason was political pressure. 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 privilege of 1857 required the Bank to open at least one branch in every district, without however setting a deadline. This was done in 1873, when the Bank was instructed to operate to cover all districts still missing by the beginning of 1877 (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 officials saw the Bank in the role of a public servant that should 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, Lombard and giro facilities (Leclercq, 2010).

As can be seen in figure 1, the intense branching activity in the 1860s and 1870s and then in the post-1897 years fits well with both mounting competition from commercial banks in the 1860s as well as 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 looks at a population of cities, where the Bank of France has not opened a branch office yet, and tries to explain how long it takes (time to event) until a branch office is opened (event). Duration analysis is appropriate as the Bank never closed a branch, i.e. the status of a city can only change from 0 to 1 but not vice versa. We take as population all urban agglomerations in France, which corresponds to a city of at least 2,500 inhabitants. This gives 782 potential locations for branches in 1880.[13] Between 1830 and 1913 the Bank of France opened 140 branch offices.

The regression model is as follows:

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

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 set equal to 0. Previous historical research summarized above suggests the inclusion of both political and economic factors as explanatory variable. Because it took at least a year to open a branch, once a decision was taken, all right-hand side variables are lagged 1 year. Economic factors account for the attractiveness of establishing a discount business in a given city. The 'economic' explanatory variables are the following. First the population $pop_{i,j,t-1}$ of the city is a proxy for the size of the local economy. Second we include a variable indicating whether the district was contaminated by the phylloxera during the previous year ($Shock_{j,t-1}$). Third we include a variable indicating whether a deposit bank operated a branch during the

[13] this number was pretty stable. It levelled at 727 in 1851 and 782 in 1913.

previous year in the city, in which case we set the categorical variable $Bank_{i,j,t-1}$ to one (and to 0 if there is no branch operated). Fourth we include the default rate variable $DR_{i,t-5_t-1}$, averaged over the last five years from $t--5$ and $t--1$ so as to smooth the year-on-year variation of the default rate. Fifth the population of the district $pop_district_{i,j,t-1}$ 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. The default rate and the shock variable are district level variables. However as branch offices typically served a larger surrounding area, this level seems also more appropriate. The political variables include a dummy $CapCity_{ij}$ indicating whether the city is the capital (seat of the prefecture) of the district,[14] as well as the dummy variable $BoFpresent_{jt-1}$ whether the Bank of France already has a branch office operated in this city or in another city of the district. The variable prefecture accounts for the possibility that political pressure would lead to the opening of a branch office in a politically rather than economically important city. The dummy $BoFpresent_{jt-1}$ is included to capture the political pressure coming from the 1857 charter, reinforced in 1873, that required the Bank to open at least one branch in every district.

Table 7 presents the results of the estimation of the duration model with 1 year lag. Results show that both the default rate in the district and the economic crisis variable are not significant. On the contrary being a capital city of a district is strongly significant and explain the opening of branches in this city. The size of the district population also explained the opening of new branches, together with the operation of another branch in the same district. Finally it is noteworthy that the operation of a branch by one of the two main national deposit banks is also positive and highly significant in explaining the choice of the location of new facilities by the bank of France. Result of the same regression but with a two-year lag of the phylloxera variable are presented in table 8 and comfort the historical analysis that the decision by the central bank to open a branch office was not related to either the default rates or the spread of the phylloxera. Neither the timing of the opening, nor the constraints faced by the bank in terms of branch opening fit with the spread of the phylloxera across French vineyards. In fact it is likely that the high setup cost of branches and the difficulty to monitor the local discounting activity was a strong motivation for a profit maximizing central bank to avoid opening branches to mitigate

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

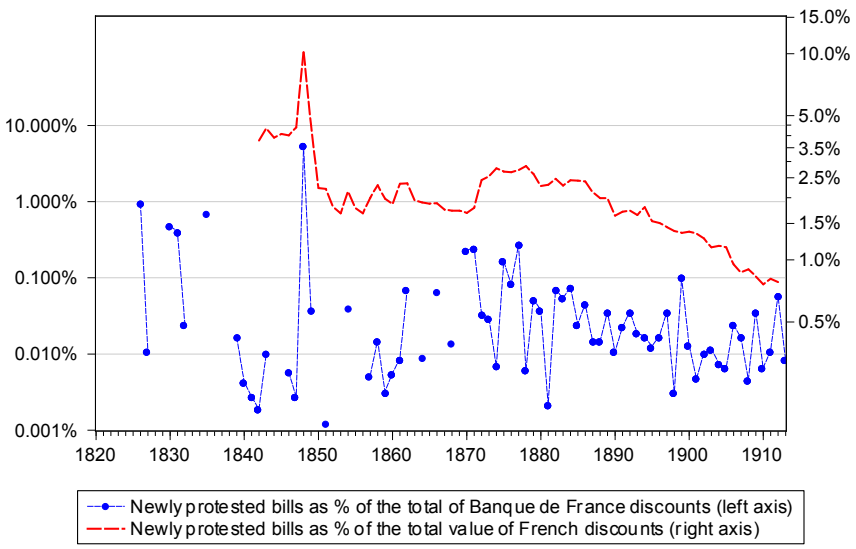


Figure 7: Unpaid bills at maturity as percentage of the discount activity of the Banque de France and of all the stamped bills issued in the economy (1860-1913)

temporary shocks.

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

In this section we ask whether the central bank has to take any losses on its discount activity in distressed district. To measure the risk taken by the bank in its discount policy, To this end we have collected the amount of protested bills discounted by the bank of France, i.e. of bills for which the payer did not pay in due time. Figure 7 plots the percentage of the bank portfolio and compares it to the percentage of protested bills at the economy-wide level. Inspection of the graph reveals that the proportion of protested bills 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 in the monitoring of default risk of the discounted 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 stock exchange, the Banque de France had a keen interest

to minimize its exposure to default so as to protect profitability. The law required the bank to discount only bills endorsed by at least three notoriously solvent persons. Endorsers must had "skin in the game" since the signature they put on the back of the bill commit them to pay the bill at maturity if the payer was in default.[15] This guarantee was easy and quite cheap to call on. It only required the ascertainment of the default on the payment in due time by a bailiff, a notary 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.[16] If a presenter did not have anybody to guarantee the payment at maturity, the bank asked the presenter of the bills to pledge liquid securities as guarantee.

The bank screened its counterparties carefully. To benefit from detailed knowledge on them, the screening the "good standing" and the decision to discount was delegated to a local discount committee composed of local traders who were coopted because of their knowledge of the businesses of presenters of bills provided that they were shareholders of the bank. The internal governance was designed to ensure the screening and monitoring the default risk very closely. The watchdog of each discount committee was the Portfolio committee composed of shareholders of the bank. It was in charge of examining the legality of the decisions of the discount committee, notably the fulfilment of the clause that forbade the bank to lend to bankrupted agents. Finally any decision of the bank was ultimately monitored by three censors in charge of overseeing the bank activities. Elected by the shareholders they selected the members of the discount committee and approved the issuance of banknotes. The implementation of the decision to discount was delegated to employees of the bank who were themselves monitored by an independent officer of the bank called an inspector. Inspectors visits the 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 exceeds his duty by deciding to bypass the right of local discount committee.

[15]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-à-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. Hence the historical literature identifies the safeness of the bills discounted by the bank of France as the "three signatures" requirement.

[16]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.

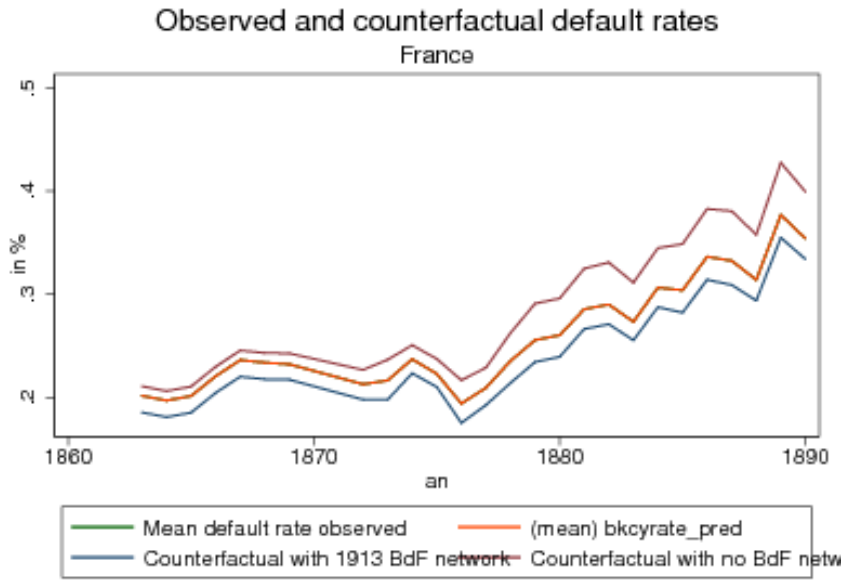


Figure 8: Observed and counterfactual default rates comparing the impact of having no branch or of having opened in 1862 all the branch operated in 1913 compared to the actual data

6.5. counterfactual—To be completed

In this section we perform the following counterfactual exercise. We use the coefficient of the regression of table 2 column (2) to predict the evolution of the default rate in two counterfactual scenarios in which the bank of France would have (1) open no branches during the period of the spread of the phylloxera or (2) would have opened the density of branches it operated in 1913 but 50 years before, in 1863. Figure 8 compares the actual evolution of the default rate (at the aggregate level) together with the default rate in the two counterfactual scenario. It shows that the branches did actually have a sizable impact on the evolution of the default rate but that the bank would have been more successful in stabilizing the crises triggered by the phylloxera if it had opened its branch network before.

7. Conclusion

The present article provides an empirical analysis of the effects of broadening the access to central bank financing using the example of France in the 19th century. Our

goal was quantitative, trying to study whether a widening of the eligibility criteria helped stabilizing economies hit by temporary negative liquidity 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. The empirical strategy is to study the consequences of the productivity shock triggered by the aphid Phylloxera on most farmers who, as a consequence, either had to fail or to reduce their demand for the other goods. This translated into an income shock for the firms of the other sectors. In an economy in which defaulting force firms to interrupt their operations, this induced a demand for credit by solvent firms to smooth the consequence of the agricultural crisis. Because entrepreneur had little incentive to strategically default, the main problem was the screening of the solvency of firms hit. For the central bank this implied liquefying the wealth of private agents, i.e. in transforming non-tradable assets into banknotes or reserves so that agents could use it to pay their bills. In this context this paper shows that the increased volume of money distributed as a lender of last resort helped smooth the consequence of the crisis especially if it is lent very broadly by the central bank. At the same time, the Banque the France did not bail out the private sector by taking over worthless assets. The identification strategy used the peculiarities created by the constraint on the implementation of 19th century monetary policy to isolate a source of exogenous variation. In the 19th century the eligibility to the refinancing of the bank of France was directly impacted by the central bank policy of opening branches, i.e. offices allowing to collect the payment at maturity. This feature allows exploiting the spatial dimension of central bank access in France, as we can argue that the opening of branches by the central bank was neither endogenous to the various shocks nor to the default rate, as branching was the outcome of a negotiation between the government and a private maximizing monopoly in search for the renewal of its privilege of banknote issuance.

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 in historical research. If there is any lesson to draw from this past experience in terms of todays monetary policy, our results stress the importance of the framework in which the central bank implemented its monetary policy in crisis time.

8. Tables

Table 1: 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
Deposit bank branches		-0.00	-0.00	-0.00
		0.00	0.00	0.00
Deposit bank branches*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
fixed effects	yes	yes	yes	yes
N	6880.00	6880.00	3010.00	2080.00

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

Residuals are clustered at the district level.

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

Table 2: Estimations with alternative measure for eligibility

	(1)	(2)	(3)	(4)
	Baseline	Additional controls	Wine intensive	1863-1890
	b/se	b/se	b/se	b/se
Shock	0.71***	1.00**	0.94**	0.50
	0.26	0.41	0.43	0.50
BdF branches	-2.20	-1.94	-4.34	-0.00
	3.60	3.48	4.75	2.62
BdF*shock	-199.35***	-209.80*	-255.38**	-208.01*
	61.44	118.51	123.86	114.05
Deposit bank branches		-0.78	-0.21	-0.85
		1.34	1.65	1.90
Deposit bank branches*shock		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		-0.076	-0.055	0.050
		0.073	0.080	0.067
R^2	0.545	0.548	0.731	0.399
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 district level.

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

Table 3: Baseline estimations

	(1)	(2)	(3)	(4)
	Baseline	Additional controls	Wine intensive	1863-1890
	b/se	b/se	b/se	b/se
Shock	0.19	0.43*	0.47*	-0.03
	0.12	0.23	0.24	0.18
BdF branches	-0.02*	-0.01	-0.02	0.00
	0.01	0.01	0.01	0.01
BdF*shock	-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		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
R^2	0.544	0.547	0.731	0.399
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 district level.

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

Table 4: Baseline estimations

	(1)	(2)	(3)	(4)
	Baseline	Additional controls	Wine intensive	1863-1890
	b/se	b/se	b/se	b/se
Shock	0.11	0.34*	0.39*	-0.11
	0.09	0.21	0.23	0.17
BdF branches	-0.02*	-0.02	-0.02	0.00
	0.01	0.01	0.01	0.01
BdF*shock	-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		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		-0.018	-0.017	0.030
		0.019	0.020	0.025
R^2	0.544	0.547	0.731	0.398
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 district level.

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

Table 5: Controlling for spatial autocorrelation of the error term

	(1)	(2)	(3)	(4)	(5)	(6)
BdF*shock	-0.456***	-200.113***	-0.159**	-0.121**	-0.744**	-211.187*
	0.113	59.381	0.063	0.054	0.338	115.801
Wdecline	0.68***	0.71***			1.21***	1.02**
	0.23	0.25			0.39	0.40
Decline			0.19			
			0.12			
Presence				0.11		
				0.09		
BdF branches	-0.02*		-0.02*	-0.02*	-0.02*	
	0.01		0.01	0.01	0.01	
BdF branches		-2.47				-2.21
per capita		3.59				3.46
Deposit banks					-0.00	
branches					0.00	
Branches deposit						-0.718
banks per capita						1.332
Deposit banks*shock					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					-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;

Residuals are clustered at the district level.

Table 6: Endogeneity of BdF 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 7: Endogeneity of BdF branching - 2 year lagged shocks

	(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

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 frontiers of France made the panel slightly unbalanced. First, in 1860 France incorporated three new districts with the annexation from Italy of the Savoy and the Nice county and the total number of districts levelled at 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 1913 period. It is dropped from our sample. Hence after 1872, France contained 86 districts. Finally 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. The quality of the data during the war years of 1870 and 1871 lead us to drop the observations of those years.

Defaults of firms working in service and industry 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 this unit defaulted on its payment obligations. Yet some innovations introduced in the course of the century need to make some assumptions. The most notable change was the 1889 law that introduced a new process through which dispute 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 lead 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 included for the 1889-1913 period both the number of *faillites* and the number of *liquidations judiciaires*. The number of defaults were used and commented by most previous scholars in level, without any correction for the potential increases in the number of firms operated (Jobert and Chevailler, 1986).

The stock of operating firms in services and industry. 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 the failures 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) the shopkeepers but also the wholesalers, any type of factories, craftsmen, banking and insurance firms. The agricultural sector was exempted from paying it, as 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.

Branches of national deposit banks and the bank of France Statistics on the activities of the central bank were taken from the annual report to the General Assembly of the Shareholders. A typical report indicated whether a branch of the bank was active or not during the year. It also provides the volume of business for every branch office and gives data on protested bills. Data on the branch network of the two most important national branch banks, Société Générale and Crédit Lyonnais, comes from Billoret (1969) and the annual reports of Société Générale.

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