Access to Finance and Technological Innovation: Evidence from Antebellum America*

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03/31/2021

Abstract

How does access to finance affect technological innovation? We provide causal evidence on the finance-innovation nexus and on the role of labor practices in shaping this relation. We exploit a unique setting—antebellum America—where staggered adoption of free banking laws across states encouraged bank entry, and spatial variation in the use of exploited workers in agriculture generated differences in producers' demand for labor-saving technologies. Results show that access to finance spurred innovation, but the positive effect on agricultural innovation diminished with labor exploitation. Where exploitative labor practices were pervasive, finance aggravated exploitation and appears to have impeded agricultural innovation.

Keywords: finance-growth nexus, banking deregulation, technological innovation, exploitative labor practices

*We are grateful to Daron Acemoglu, Andres Almazan, Ramin Baghai, Charles Calomiris, Michael Ewens, Carola Frydman, Matt Jaremski, Peter Koudijs, Debarshi Nandy, Jordan Nickerson, Paul Rhode, Joshua Rosenbloom, Elena Simintzi, Guillaume Vuillemey, Nicolas Ziebarth, and Miao Ben Zhang, as well as seminar and conference participants at WAPFIN@Stern, 2018 Texas A&M Young Scholars Finance Consortium, 2018 Chicago Financial Institutions Conference, 2018 Texas Finance Festival, 2018 University of Kentucky Finance Conference, 2018 SFS Cavalcade, 2018 WFA, 2018 CICF, 2018 NBER SI Innovation, 2018 EFA, 2019 AFA, 2019 FIRS, Cornell University, Arizona State University, Auburn University, University of Calgary, and University of California Los Angeles for helpful comments. Contact information, Mao: ym355@cornell.edu; Wang: Jessie.Jiaxu.Wang@asu.edu.

1 Introduction

There is a long-established consensus that financial markets are vital for economic growth (Schumpeter, 1934; Levine, 1997; King and Levine, 1993a). Yet, the way financial markets affect innovation and, in particular, the effectiveness of access to finance in promoting innovation is not fully understood (Hall and Lerner, 2010; Kerr and Nanda, 2015). In this paper, we make two contributions to the understanding of the factors that drive innovation. First, using a novel bank-deregulation shock, we provide new evidence on how access to finance impacts technological innovation. Second, we fill a gap in the literature by examining the effect of finance on innovation when producers use different labor practices. We find that access to finance, which generally promotes innovation, can also depress innovation by reducing the cost of labor. Our results suggest that producers facing high labor costs have a strong incentive to finance technological innovation. But if the cost of labor declines with access to finance, the incentive to innovate will also decline; the net effect on innovation is ambiguous and has not previously been explored.

Identifying the effects of finance and labor practices is challenging in today's world because financial markets are interconnected, and labor is mobile. We tackle these challenges by turning to antebellum America—from just after the War of 1812 until 1860, before the onset of the Civil War—as an ideal laboratory. First, this period witnessed the staggered passage of free banking laws in 18 states, a novel setting in which to identify banking shocks. Due to transportation costs and restrictions on interstate branching, antebellum banks were mainly local businesses. Access to banks was limited because the chartering system posed significant barriers to entry. By replacing charter requirements with "free entry" under a fixed set of standards, the passage of a free banking law encouraged bank entry and thus provided a positive shock to a state's access to finance.

Second, during the antebellum era, exploitative labor practices enabled by the institution of slavery were prevalent. Because of their property rights over enslaved workers, planters were able to extract the lion's share of enslaved labor's marginal product, paying a low maintenance cost.[1] These planters had less incentive to shift away from labor-intensive production methods than farmers who faced competitive labor costs. Hence, regional divergence in the use of exploited workers in agriculture led to heterogeneity in produc-

[1]Enslaved labor should not be understood as "cheap labor," as Wright (2006) stresses. In fact, the market *value* of an enslaved worker was high. In this paper, we use the terms "labor costs," "cost of labor," and "unit cost" interchangeably to refer to the notion of marginal labor cost faced by the producer. The marginal cost of using an enslaved worker was reflected in the maintenance cost or the hire rate, which is to be distinguished from the market value. The key difference between an exploited worker and a wage-earner is the marginal cost of labor relative to the marginal product: the subsistence return received by enslaved workers was much lower than the value created by them.

ers' demand for labor-saving technologies. Furthermore, where exploitative labor practices were pervasive, banks' assistance in trading and mortgaging enslaved workers aggravated exploitation. In comparison, banks elsewhere provided financing for merchants and manufacturers who competed with agriculture for workers, further increasing the demand for agricultural mechanization. This unique feature allows us to shed light on the net effect of finance on innovation.

To assess the causal impact of access to finance on innovation, we use a difference-in-differences approach that exploits the staggered passage of free banking laws. The historical narrative appears to suggest that the timing of the laws' enactment across states was plausibly exogenous.[2] Using a hazard model, we show that the likelihood of a state passing a law was not affected by state-level determinants of innovation or trends in innovation prior to the law's passage. Furthermore, a significant number of free banks entered following the law's passage, whereas charter banks did not exit or become smaller. The evidence supports the notion that the adoption of free banking imparted a positive shock to a state's access to finance.

Our baseline regressions establish a significant, positive effect of improved access to finance on technological innovation. After a state adopted the free banking law, the number of patents granted increased significantly in subsequent years. The economic magnitude is consequential. On average, a state that passed the law generated 12.13 more patents in the third year of free banking than did states without free banking; this magnitude accounted for 16.1% of the state-level patent variability. The results are robust to controlling for state and year fixed effects, as well as for time-varying, state-specific characteristics. Free banks at times operated as innovation-inducing Schumpeterian financiers by directly supporting local innovators and entrepreneurs, as the micro-level evidence from Bodenhorn (1999) suggests. Also, free banks potentially promoted innovation through indirect channels, such as improving bank competition, boosting the money supply, and expanding the railroad network.

We conduct a battery of tests to support a causal interpretation of our results. First, we examine the dynamics of innovation surrounding the law's passage. The innovation output shows no prior trend, indicating that reverse causality is unlikely a concern. Second, we conduct a placebo test using pseudo-treated groups and conclude that the results cannot occur mechanically in the data. Finally, we confirm that our results are not driven by observations with zero patents, earlier antebellum years, or contemporaneous law changes.

Consistent with the local nature of the antebellum banking markets, we find that access to free banks was

[2]For example, the law's passage in New York State was triggered by a kidnapping incident and was referred to as having a "serendipitous nature" (Bodenhorn, 2006).

positively and significantly associated with innovation outcomes at the county level. To address the concern that the entry of free banks in a county might be endogenous to local economic conditions, we employ an identification strategy that resembles a regression discontinuity design. Specifically, we compare contiguous counties along a shared state border, where the free banking law was passed on one side. This method allows us to minimize the confounding effects of unobservable variation in local economic conditions. Results show that the coefficient estimates on free banks' entry continue to be positive and statistically significant, reinforcing the causal effect of free banking on local innovation outcomes.

Having established a robust and positive impact of access to finance on technological innovation, we turn to the role of labor practices in shaping the finance-innovation nexus. Antebellum slavery, an extreme form of exploitation, provides a window through which to study the impact of exploitative labor practices. Enslaved laborers worked primarily in agriculture; they were forced to work long hours with little or no pay. Planters' property rights enabled them to extract a large share of the marginal product of enslaved labor while paying a low maintenance cost. If economizing on labor costs poses a strong incentive to replace labor, producers using exploitative labor practices would be less keen to shift away from labor-intensive production methods. In contrast, producers without access to exploited labor faced a marginal cost of labor comparable in magnitude to labor's marginal product and had stronger incentives to replace labor with machines. Accordingly, we predict that access to finance has a weaker impact on labor-saving innovation in regions with exploitative labor practices.

To test this prediction, we measure the extent of labor exploitation using the fraction of a state's (county's) population that was enslaved when the state entered the antebellum era.[3] Because the spatial variation in labor exploitation was manifested chiefly in agriculture, we focus on antebellum agricultural patents, which are commonly considered labor-saving.[4] Consistent with our prediction, the estimates of both the state-level and county-level regressions show that labor exploitation was negatively associated

[3]We pursue several strategies to better understand if the observed effect of labor practices is causal or spurious. First, to alleviate concerns about reverse causality, we measure labor exploitation when a state entered the antebellum era because the initial value is arguably exogenous to local economic and financial development. Second, we consider two plausibly exogenous shocks to the supply of exploited workers. One is the county-level sudden deaths among enslaved populations due to the 1850s cholera pandemic. The other is the staggered arrival of Irish immigrants—another group of highly exploited workers at the time.

[4]While technical change since the twentieth century has been skill-biased and labor-complementary, technology in nineteenth-century America was predominantly a substitute for human strength and skilled labor (Goldin and Sokoloff, 1984). Acemoglu (2010, p. 1040) notes that "it may well be that the technological advances of the late eighteenth and nineteenth centuries in Britain and the United States were strongly labor saving and did induce innovation and technology adoption." There are several explanations for the structural change. First, the high land-labor ratio in the early settlements made labor a very expensive factor at that time (Temin, 1971). Second, technology-skill complementarity emerged in manufacturing early in the twentieth century as technologies, known as batch and continuous-process methods of production, spread (Goldin and Katz, 1998). Finally, the education and skill sets of workers shifted the nature of technical change in the twentieth century (Acemoglu, 2002).

with the impact of free banking on agricultural innovation. The results are robust to controlling for the level of free bank entry and observable state characteristics, including industry composition, educational attainment, foreign-born population, innovation growth, and access to railroads. To mitigate concerns about unobservable differences between areas that abolished slavery and those that did not, we restrict the analysis to the subsample that performed exploitative labor practices and find the results continue to hold.

Our estimates reveal that although, on average, agricultural patenting increased after the arrival of free banking, agricultural patenting declined in states where labor exploitation was severe. While surprising at first glance, this finding is consistent with the mechanism of finance impeding innovation by exacerbating the extent of exploitation and reducing labor costs. In states where slavery was pervasive, enslaved people represented the bulk of planters' investment and wealth (Wright, 2006). Bankers provided mortgages and equity loans, enabling the financialization of slavery (Martin, 2010; Murphy, 2017a). Hence, improved access to finance likely increased the use of exploited labor and reduced producers' marginal labor cost. This dynamic response of labor cost discouraged producers from adopting labor-saving technologies, thereby breaking the previously documented finance-innovation nexus.

Consistent with the proposed mechanism, we find that free banking increased wage rates in areas without labor exploitation and decreased the marginal cost of labor in areas where exploitation was pervasive. Our evidence supports two potential channels for the decline in labor costs in states with exploited workers. One channel is that free banking led to an increase in the enslaved population and to more widespread slavery, consistent with historical accounts of the interregional trade and migrations of enslaved people (Conrad and Meyer, 1958; Fogel and Engerman, 1974). Another channel is the increased concentration of enslaved workers on large plantations after passage of the free banking law. Economies of scale on large plantations likely led to more intense monitoring, lower operating costs, and higher productivity, suggesting an increase in labor exploitation. Both channels accord with the mechanism that free banking aggravated exploitation, reduced labor costs, and slowed technical progress in agriculture. Our results thus highlight a novel and nuanced interaction between access to finance and labor practices, which jointly determine innovation outcomes.

To establish the causal effect of exploitative labor practices, we use two plausibly exogenous shocks to the supply of exploited workers. The first shock is the 1849–1854 cholera pandemic, a deadly outbreak that disproportionately struck the lower classes. This pandemic caused sudden reductions in the enslaved population in affected counties, generating a negative shock to the extent of labor exploitation by planters

and a stronger incentive for them to switch to machines. To measure the county-level exposure to the shock, we hand-collect novel data from the 1850 Census Mortality Schedules. The second shock is the influx of Irish immigrants who came to America in the period 1820–1860 to escape poverty, hunger, and religious persecution. These Irish immigrants often took any jobs they could get at meager pay and were largely exploited by employers. The staggered arrival of Irish immigrants in each state thus provided a positive shock to the extent of labor exploitation by local producers. Our results show that innovation responded more positively to access to free banks in areas where planters faced more cholera-caused deaths among the enslaved population, and in areas with fewer arrivals of Irish immigrants. Together, our evidence substantiates a causal interpretation of the relation between labor exploitation and the sensitivity of innovation to financial development.

Our paper contributes to the literature on the finance-growth nexus. Pioneered by Schumpeter, this vast literature has established a positive link between financial development and economic growth.[5] However, recent evidence is mixed on the effect of banks on innovation. Hall and Lerner (2010), for example, discuss concerns about the effectiveness of banks (and credit) in financing innovation, whereas studies that assess US banking deregulation from the 1970s to the 1990s show that bank financing is vital for firms that engage in innovation (Amore et al., 2013; Chava et al., 2013; Cornaggia et al., 2015). Adding to this literature, we use the staggered adoption of free banking laws in antebellum America as a shock to bank entry.[6] Our evidence reveals a novel mechanism of finance having an ambiguous effect on innovation by shifting the cost of labor. Ours is the first study we are aware of that highlights a nuanced interaction between two factors—labor practices and access to finance—which jointly determine innovation outcomes.

By examining an extreme form of exploitation in history, our study reveals the negative impact of exploitative labor practices, which remain a widespread phenomenon today.[7] In line with historical institutions

[5] See, for example, King and Levine (1993a,b), Jayaratne and Strahan (1996), Levine (1997), Bodenhorn (2000), Beck et al. (2000), Black and Strahan (2002), Brown et al. (2009), Kerr and Nanda (2009), Chemmanur et al. (2014), and Carlson et al. (2020).

[6] We are among the first to examine the staggered rollout of the free banking laws. Our study thus also adds to the assessment of the real effects of free banking (Rockoff, 1974; Rolnick and Weber, 1983; Bodenhorn, 1990; Economopoulous and O'Neill, 1995). Jaremski and Rousseau (2013) find that free banks did not play a direct role in sustaining economic growth when compared to charter banks. Their data and approach differ from ours, which potentially explains the different conclusions. First, they measure growth using decadal changes in urbanization, manufacturing capital, and farm capital in the 1850s and 1860s; instead, we measure growth using patenting activity at annual frequency—a more granular account of growth via technological advances. Second, their analysis uses county-level aggregates for free and charter banks as independent variables and focuses on the cross-sectional association between banks and economic outcomes for the two decades. Instead, our specification uses the staggered bank-deregulation shocks, which sheds light on the causal effect.

[7] Although forced labor has been banned, labor exploitation remains widespread. According to an International Labour Organization report, 25 million people worldwide were forced into exploitative labor in 2016. Victims of forced labor suffered multiple forms of coercion from employers, including withheld wages, threats of non-payment of wages due, and threats of violence (International Labour Organization, 2017).

and practices having persistent and long-term consequences (D'Acunto, 2018; D'Acunto et al., 2018), slave trades are shown to have adversely affected present-day economic outcomes (Nunn, 2008; Pierce and Snyder, 2017; Levine et al., 2020). Our findings highlight a first-order channel through which exploitative labor practices depressed growth: producers using exploited workers lacked an incentive to adopt labor-saving technologies. In this sense, our findings are in line with Wright (2006), who emphasizes the long-run inefficiency of slavery. Although slavery might have seemed an "efficient" means of production for planters at the time, such exploitative conduct likely crowded out investment in machinery and locked people into a production method that would have proven inefficient in the long run.

This paper proceeds as follows. Section 2 provides historical background and develops hypotheses. Section 3 describes the data. Section 4 examines the effect of free banking on innovation, and Section 5 focuses on the role of labor practices in shaping this relation and provides causal evidence using the 1850s cholera pandemic and the influx of Irish immigrants from 1820 to 1860. Section 6 concludes.

2 Historical Background and Hypothesis Development

2.1 Antebellum Technological Innovation

The antebellum era refers to the period in US history from just after the War of 1812 until 1860 before the beginning of the Civil War. During this time, the country experienced rapid economic growth. Innovations such as mechanical reaper, steel plow, rotary printing press, and sewing machine radically transformed the production process. Behind this vigorous inventive activity was a sustained acceleration of patenting and a solid patenting system that provided avenues for commercializing innovations. It took several months for a patent to be examined after the filing of an application. At times inventors would sell their patents to manufacturers who were better at commercializing and producing. For instance, Walter Hunt was granted a patent for the safety pin in 1849. He sold the patent right for about $10,000 (in today's dollars) to W. R. Grace and Company, who then mass-produced the safety pin.

The boom in patenting appears consistent with an emphasis on demand-induced advances in inventive activity. In particular, labor cost acted as a potentially powerful inducement for the invention of labor-saving tools and technologies. As Habakkuk (1962, p. 17) noted, "the dearness and inelasticity of American, compared to British labour, gave the American entrepreneur... a greater inducement than his British counterpart to replace labour by machines." This labor-saving incentive was especially relevant in agriculture, in which tasks such as reaping, threshing, and winnowing were labor intensive (Rasmussen, 1982; Goldin

and Sokoloff, 1984).[8] For example, in New York, Pennsylvania, and Ohio, where farm labor was scarce, inventions for winnowing grain were in great demand. However, on southern plantations, completing the same task relied intensively on enslaved workers who used winnowing baskets and winnowing barns.

2.2 Limited Access to Banks and the Passage of Free Banking Laws

Access to finance was generally limited in the early nineteenth century. The widespread use of capital markets was uncommon, and banking services were local. Banks needed to be chartered by a state legislature. A state typically had only a few charter banks, which operated in major cities. Due to restrictions on interstate branching, information frictions, and transportation costs, banking was legally and economically a local affair.[9] A legislative committee from Rhode Island reported "the greater part of the banks are, properly speaking, local, and managed for the accommodation of the people residing in or near the places of their location" (Congress, 1837, p. 44).

Several factors contributed to the limited access to banks. First, the chartering system was a tedious and cumbersome process that severely restricted the number of banks opened. Second, the approval of a charter often depended on political influence that was aimed at protecting the interests of incumbent banks. Once a bank was successfully chartered, its supporters then lobbied heavily against the formation of new, competing banks. As Hammond wrote, "It had long been difficult to get new bank charters in New York, because the [Albany] Regency kept the number down conservatively" (Hammond, 1957, p. 574). As a result, some parts of the country had little access to banking facilities, while banks in many other locations enjoyed a virtual monopoly (Murphy, 2017c). Third, early charter banks operated only in major cities and rarely provided financial services to ordinary households in peripheral areas. In fact, these charter banks conducted extensive insider lending to members of their own boards of directors or to others with close personal connections to the boards (Lamoreaux, 1996). In the antebellum South, farmers with good collateral had to obtain credit from alternative local intermediaries such as country stores and plantation owners (Koudijs and Salisbury, 2020).

[8]Unlike the typical agricultural machinery, the cotton gin patented by Eli Whitney in 1794 is not a labor-saving invention. While it increased labor productivity, cotton gin did not reduce but rather dramatically increased the demand for enslaved labor for two reasons. First, cotton gin made cotton a lucrative crop and rejuvenated the cotton trade. Second, cotton gin saved labor in removing seeds, but it did not save the need for enslaved workers to grow and pick the cotton.

[9]Charters and corporate bylaws that restricted a bank's office to a specific place did not restrict its lending to that place, but information asymmetries narrowed the pool of potential borrowers. Familiarity with customers was closely associated with geographic proximity because proximity lowered the cost of gathering information, monitoring borrowers, and enforcing the terms of the lending agreement (Bodenhorn, 2006). The Second Bank of the United States operated from 1816 to 1836 and had 25 branches. The bank's essential function was to regulate the public credit issued by private banks through the fiscal duties it performed for the

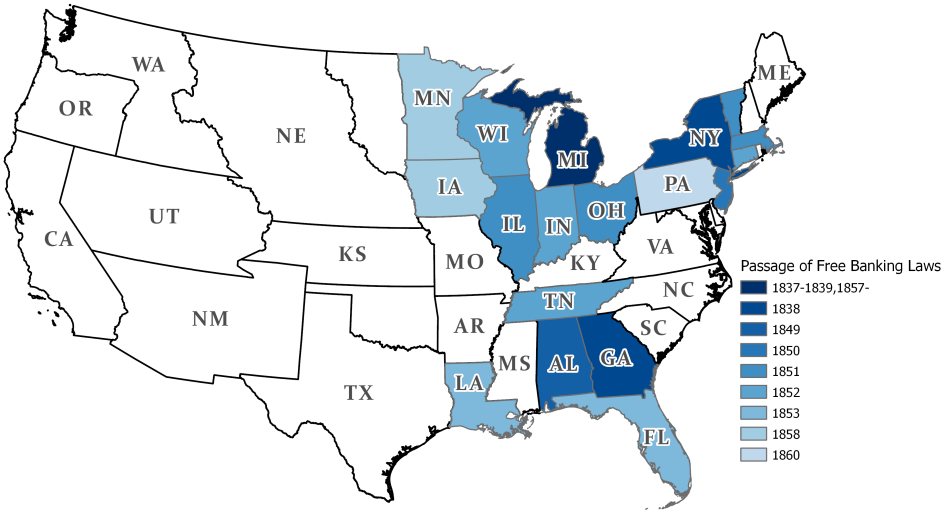


Figure 1. Passage of free banking laws. This figure maps the staggered timeline of passage of free banking laws in individual states. The states and territories are labeled with their abbreviations, and their borders drawn according to the 1860 map. States established after 1812 only enter our sample starting from the year of establishment, as listed in Table A.1 in the Online Appendix.

The free banking laws initiated banking deregulation reforms by removing the necessity of a legislative charter for a bank to be established.[10] The adoption of free banking laws was staggered across 18 states; the first was in Michigan in 1837 and the last was in Pennsylvania in 1860. Table 1 lists the 18 states and their adoption year. These states included seven in the Midwest, five in the South, and six in the Northeast. As shown in Figure 1, free banking spread through every region. The laws allowed "free entry" upon a bank's satisfaction of the stipulated requirements, thereby lowering barriers to entry (Economopoulous and O'Neill, 1995). In effect, anyone who had the required paid-in capital was allowed to open a bank that could issue its own notes, take deposits, and make loans.[11] This deregulation appealed both to Jacksonian Democrats, who believed the chartering system was too monopolistic and aristocratic, and to the more commercially oriented Whigs, who thought that the chartering process was too slow to address the financial needs of a rapidly expanding frontier.

US Treasury (Hammond, 1957).

[10]The free banking laws did not preclude the legislatures from issuing charters. In fact, many free banking states continued to issue charters, thus establishing a dual banking system (Jaremski and Rousseau, 2013).

[11]The free banking era was not a period of laissez-faire banking. Despite unrestricted entry, banks established under the free banking laws were subject to strict oversight intended to protect the noteholders. First, free banks had to deposit designated state and federal bonds as collateral for all notes issued. Second, they were required to pay specie for their notes on demand and at par value. Finally, free bank stockholders had double liability, i.e., they were liable for bank losses in an amount up to the value of their stock. Most free banking laws provided additional protection for noteholders by giving them first lien on the assets of a bank (Rolnick and Weber, 1983).

[Table 1 about here]

Historians have not yet reached a consensus on the factors that determined where and when the laws were passed. In Online Appendix I, we provide a brief state-banking legislative history to describe events leading up to the law's passage. Overall, early banking legislation was in its infancy, and the development of events was fairly idiosyncratic across states. In some states, the law's enactment seems to be initiated by accidental events. An interesting example is from the state of New York, as discussed in detail in Bodenhorn (2006). The legislation was triggered by an unlikely event, the kidnapping of a man named William Morgan after he threatened to reveal the secrets of the Masons. Investigations into the kidnapping implicated several famous Masons who were politically connected with the Regency. As legislative debates on banking policy became anti-Masonic, the Regency lost support and the free banking law was eventually adopted. Bodenhorn calls this the "serendipitous nature of economic reform." We formally test the exogenous nature of the adoption across states in Section 4.1.

Microlevel evidence suggests that antebellum free banks assisted, perhaps even animated, inventions and entrepreneurship. Bodenhorn (1999) examines surviving loan-level records of the Black River Bank of Watertown, New York, and shows that the bank operated as an *innovation-inducing Schumpeterian bank*. Banker Paddock founded the Black River Bank in 1844 under the terms of New York's free banking law. By the early 1850s, the bank had grown into the second largest bank in Watertown. Using two discount books for the period 1844 to 1859, Bodenhorn matches the borrowers' names to city directories and manuscript censuses to provide insights into the banker's lending practice. He finds that merchants, who had good collateral and were favored borrowers of charter banks, were relatively underrepresented, whereas manufacturers, small businesses, and young entrepreneurs were overrepresented.

A notable example was the financing of Bradford, who invented the portable steam engine. In 1849 Bradford constructed a working model of a portable steam engine and formed a partnership with machinist Hoard. Hoard & Bradford turned to banker Paddock for financial assistance. With a number of notes from the bank, the partnership flourished in the 1850s, ultimately developing by 1857 into a firm with 150 machinists. The Black River Bank's support of Hoard & Bradford was not atypical. There were several other instances of the bank offering financial assistance to fledging upstarts, including to Remington, who established the Remington paper mill in 1853, and to Hotchkin, who established a tannery and harness manufactory in Watertown in 1854. These instances reflect well on Paddock's role as a Schumpeterian

banker in financing innovative entrepreneurs.

2.3 Exploitative Labor Practices

Exploitative labor practices enabled by the institution of slavery were prevalent at the time. Relative to Europe, America was land abundant and labor scarce, with the bulk of the labor force working in agriculture (Rasmussen, 1982; Rosenbloom, 2018). Labor markets were segmented across regions with considerable heterogeneity. The regional divergence in the practice of slavery gave rise to differences in the use of exploited labor.

In states with no enslaved population, workers had property rights in their own labor and were wage earners. Like in contemporary labor markets, workers entered into agreements to provide labor services for a limited time, and producers incurred a unit cost of labor comparable in magnitude to labor's marginal product. The westward migration and the rapid growth of the Northeast manufacturing sector were associated with wages adjusting upward, especially for women and children, in both the agricultural and manufacturing sectors (Goldin and Sokoloff, 1982). For example, textile mills expanded the factory workforce by attracting women from rural areas of New England, offering higher wage rates than they could earn at home (Lebergott, 1960). The Midwest was a major engine of agricultural growth, thanks to the vast amount of fertile soil suitable for heavy cereal crops. Although land was cheap to acquire, the supply of agricultural labor was scarce and unreliable. Demands for harvest labor occurred in a short window, which typically drove up wages (Bidwell and Falconer, 1925; Rosenbloom, 2018). The high cost and difficulty of hiring agricultural labor were an important consideration in the rapid adoption of new cultivating inventions such as steel plows and mechanical reapers (David, 1975; Rasmussen, 1982).

There were 28 out of the 39 states entering the antebellum period with some enslaved population.[12] In these areas, enslaved labor and wage-earning labor coexisted. Unlike wage earners, enslaved workers, who formed the major workforce in agriculture, faced *labor exploitation* (Ransom and Sutch, 2001). Enslavers had property rights in the labor of enslaved workers. This property rights regime meant relatively unrestricted control over labor's time and effort, ensuring that sufficient labor was available at crucial times in the agricultural cycle.[13] This observation accords with agricultural historians who argue that slavery

[12] Some states (including New York, New Jersey, and Illinois) abolished slavery with gradual emancipation, and the existing enslaved population had to remain with their former owners as indentured servants. The enslaved population in these areas was generally small; see Table A.1 in the Online Appendix.

[13] Whereas wage earners might also have experienced some extent of labor exploitation, the nature of exploitation faced by an enslaved worker was institutionalized by the property rights system (Wright, 2006): Wage earners could have walked out or insisted

relieved a labor constraint faced by those northern farmers (see, e.g., Fleisig, 1976).

Exploitative labor practices allowed enslavers, the "laborlords" as Wright (2006) puts it, to extract a large proportion of enslaved worker's marginal product while paying a low maintenance cost. As Adam Smith famously said of the enslaved labor in his condemnation of slavery, "Whatever work he does beyond what is sufficient to purchase his own maintenance, can be squeezed out of him by violence only." Representative McDuffie of South Carolina spoke of "efficient agricultural labor operating at 12.5 cents a day and producing one of the most valuable staples on the earth" (Congress, 1832). This meant a cost of $3.75 a month, compared to the wage of $7.33 plus board paid to free agricultural labor in the South Atlantic area. Using data on costs and returns for slaveholding, Lebergott (1960) estimates that the cost excluding board ran merely to about $1.25 a month. A similar estimate was given in Conrad and Meyer (1958). Such differences in labor costs should not be interpreted as differences in productivity. Despite their low unit cost, enslaved field hands were on average harder working and more efficient than their white counterparts (Fogel and Engerman, 1974). In sum, slavery led to exploitative labor practices. The lower unit cost of labor relative to the product of labor potentially obviated the need for producers to pursue the invention and improvement of labor-saving technologies.

The enslaved population increased nearly fourfold from 1810 to 1860.[14] Meanwhile, markets for trade of enslaved people were well-developed. Trade was allocated by a system of regional specialization (Conrad and Meyer, 1958), with New Orleans serving as the site of the largest market (Calomiris and Pritchett, 2016). Throughout this time, banks were involved in the trade by underwriting the sales of enslaved people. As noted by Murphy (2017a, p. 1), "The use of slaves as collateral, and the readiness of banks to foreclose on this property, placed southern banks at the heart of the buying and selling of slave property, one of the most reviled aspects of the slave system."

2.4 Hypothesis Development

In this section, we develop testable hypotheses motivated by theory and literature. We contend that both access to finance and labor practices are critical factors in shaping innovation outcomes. To articulate the theoretical motivation for our hypotheses, we provide a conceptual framework in Appendix B where we show that the equilibrium level of labor-saving innovation equates its marginal cost with its marginal benefit.

on improved conditions or wages, but enslaved workers could not.

[14]High birth rates and low mortality rates contributed to an exceptional rate of natural increase. In addition, Collins (1904) lists extensive evidence that at least 270,000 enslaved were introduced into the US from 1808 to 1860; the importation of enslaved workers from abroad had been prohibited by 1808, but the laws were not entirely effective.

The marginal cost, motivated by information frictions and transaction costs inherent in financing innovative activities, is inversely related to access to finance. The marginal benefit of labor-saving technology is positively associated with the marginal cost of labor. Consequently, two factors—access to finance and the marginal cost of labor—jointly determine innovation outcomes.

According to our first testable prediction of the model, all else equal, innovation increases with access to finance. The idea is that innovative projects by nature are difficult to evaluate, have skewed and uncertain returns, and require a long-term commitment of resources (Kerr and Nanda, 2015). Access to finance mitigates information frictions and transaction costs, facilitates exchange, relaxes entrepreneurs' financing constraints, and diversifies risks associated with uncertainty and long-run capital commitments (King and Levine, 1993b; Levine, 1997). These benefits are consistent with a large literature that suggests a positive, first-order relationship between finance and growth. Schumpeter (1934, Ch. 3) argued that well-functioning banks stimulated technological innovation by identifying and funding entrepreneurs with the best chances of successfully implementing innovative products and production processes. In their classic cross-country study, King and Levine (1993a) find empirical support for the finance-growth nexus. Further evidence from the US shows that state-level banking deregulation accelerated economic growth (Jayaratne and Strahan, 1996), fostered entrepreneurship (Black and Strahan, 2002; Krishnan et al., 2014), and spurred corporate innovation (Amore et al., 2013; Chava et al., 2013; Cornaggia et al., 2015; Hombert and Matray, 2016). Meanwhile, Nanda and Nicholas (2014) show that bank distress in the Great Depression reduced patenting, suggesting a positive relation between credit markets and innovation.[15]

In the antebellum era, the widespread use of capital markets was uncommon, and bank services were local; hence, we expect to see an overall positive response of innovation to bank entry. Local bankers might help entrepreneurs and inventors in several ways. First, local bankers provided more accessible financial support for the adoption of new technologies. McKinnon (1973, p. 13) emphasizes "the virtual impossibility of a poor farmer's financing from his current savings the whole of the balanced investment needed to adopt the new technology. Access to external financial resources is likely to be necessary." Second, as the example of Black River Bank described in Section 2.2 demonstrates, local bankers acted as Schumpeterian financiers to identify and endorse promising entrepreneurs—much like the role played by today's venture capitalists. Finally, banks helped expand the market size by promoting exchange and made it

[15]The positive role of finance in innovation is not confined to credit markets. Some studies, for example, emphasize the importance of equity markets (Brown et al., 2009; Hsu et al., 2014; Acharya and Xu, 2017; Dong et al., 2021), while others highlight the role of venture capital (Chemmanur et al., 2014).

profitable for entrepreneurs to commercialize the new inventions. This is consistent with the observation of Lamoreaux and Sokoloff (1996, p. 17) that "it was primarily the development of institutions that facilitated the exchange of technology in the market that enabled creative individuals to specialize in and become more productive at invention." The above discussion leads to our first hypothesis.

Hypothesis 1. Improved access to finance, all else equal, leads to more innovation.

Regarding labor-saving innovation, the conceptual framework described in Appendix B also predicts a negative cross-sectional relationship between the degree of labor exploitation and the sensitivity of innovation to financial development. Consistent with Habakkuk's (1962) hypothesis, economizing on labor costs poses a strong incentive for producers to adopt labor-saving technologies.[16] Hence, the marginal benefit of labor-saving innovation and its sensitivity to access to finance depends on the marginal cost of labor. In the context of antebellum America, labor markets were segmented; there was considerable heterogeneity across regions in the degree of labor exploitation as reflected in the practice of slavery. In regions where exploitative labor practices were absent, producers incurred a unit cost of labor comparable in magnitude to labor's marginal product; we expect access to finance to impact technological innovation substantially. Conversely, in regions where exploitative labor practices were pervasive, planters used their property rights over enslaved workers to extract part of workers' marginal product, and thus had little incentive to shift away from labor-intensive production methods. In those regions, we expect access to finance to have a weaker impact on technological innovation. Together, this leads to our second hypothesis.

Hypothesis 2. Improved access to finance has a weaker impact on labor-saving innovation in regions that use exploitative labor practices.

So far, we have taken the unit cost of labor in a region as fixed, yet labor cost may respond to improved access to finance. If so, the link between labor cost and labor-saving innovation will provide an additional channel through which finance influences innovation. This second channel adds nuance to the sensitivity of innovation to finance. A rise in labor cost strengthens the finance-innovation nexus, whereas a concomitant decline in labor cost weakens (and can even break) the finance-innovation nexus. Take the Midwest region for an example. Better financing promoted the development of the manufacturing sector, which competed for labor supply and aggravated the scarcity of farm labor. Hence, we should expect more inventions and

[16] Similarly, Rosenberg (1969) contends that firms tried to invent labor-saving technologies when labor was scarce. Acemoglu (2010) further establishes conditions under which the high cost of labor encourages technological advances. Hornbeck and Naidu (2014) and Bena et al. (2020) provide empirical evidence supporting the theoretical prediction.

improvements in farm technology in those states. By contrast, in regions where slavery was prevalent, if banks further reduced the unit cost of labor by exacerbating the extent of labor exploitation (e.g., through facilitating enslaved trade and increasing the concentration of slaveholding), we might observe a negative relation between finance and innovation. We therefore test the following hypothesis.

Hypothesis 3. If improved access to finance exacerbates the extent of labor exploitation, the impact of finance on innovation is ambiguous and might be negative.

3 Data and Summary Statistics

To assess the effect of free banking on innovation and the role of labor practices in shaping this relation, we gather data on the passage of the free banking law, bank balance sheets, patents, proxies for labor exploitation, and control variables.

3.1 Measuring Access to Finance and Free Banking Events

We measure access to finance using detailed bank data from Weber (2006, 2008), which are complemented with hand-collected records. While the former provides comprehensive documentation for the antebellum charter banks, the presence of free banks in Southern states appears underestimated, especially in Louisiana and Tennessee. Therefore, we enhance the dataset by hand collecting information from a set of secondary sources.[17] For example, the *Merchant's and Banker's Almanac* documented that seven out of a total of 11 Louisiana banks in 1859 were free banks; similarly, 16 out of a total of 36 Tennessee banks in 1855 were free banks. See Figure A.1 and Figure A.2 in the Online Appendix for examples of the *Merchant's and Banker's Almanac* records.

We assemble bank-level data which consist of the name of the bank, its charter type, the location of operation, entry and exit dates, and detailed balance sheet items by year, including total assets, loans and discounts (all in thousand dollars). When comparing the size of their balance sheets, the average free bank was slightly smaller than the average charter bank but was comparable. For example, an average free bank had a total asset of 0.57 million dollars, compared to an average charter bank's asset of 0.77 million dollars. The largest free bank was the Bank of Commerce in New York with an asset size of 18 million dollars, and the largest charter bank was Citizens Bank of Louisiana with an asset size of 16 million dollars.

[17]The secondary sources include the *Merchant's and Banker's Almanac* (1856, 1860), Economopoulous and O'Neill (1995), the *Bankers' Magazine and Statistical Register*, and the Comptroller of Currency Report (1876).

The passage of the free banking law is represented by an indicator variable, *Free banking*. For the 18 states that adopted free banking, we set the *Free banking* indicator equal to zero in all the years preceding the law's passage and equal to one starting from the passage year onward. For Michigan, we allow the indicator to revert to zero starting from 1840 when the state abolished free banking and change it back to one beginning in 1857 when the state reinstated the law. For the 21 states that did not pass the law, we set the indicator equal to zero for all years.

3.2 Measuring Innovation

To measure technological innovation outcomes, we rely on the number of patents granted every year at the state and county level. The source is digitized patent filings from the United States Patent and Trademark Office (USPTO). From the original patent documents, we obtain the patent number, the year in which the patent was granted, and the state and county where the inventor resided. We link this dataset with the USPTO's historical patent files using the patent number to obtain the technology class to which the patent belonged.

To test the hypothesis that labor practices affect the marginal impact of finance on labor-saving innovation, we focus our analysis on agricultural patents for two reasons. First, as discussed in Section 2.1, the labor-saving incentive for technology adoption in the antebellum era was especially relevant in agriculture. Second, our empirical strategy leverages the spatial variation in exploitative labor practices in agricultural production. To identify patented technologies used in agriculture, we map the USPTO technology classes into 36 two-digit technological categories following Hall et al. (2001). Agricultural patents consist of those that fall into category 61 (Agriculture, Husbandry, Food).[18] Figure 2 shows the natural logarithm of one plus the total number of patents (the blue solid curve) and of agricultural patents (the orange dashed curve) over time.

Patents could miss certain valuable inventions and technologies.[19] Nonetheless, while imperfect, patent data are often the best available and widely used measure of antebellum inventive activity, particularly since

[18]This technological category corresponds to the USPTO patent classes 43 (Fishing, Trapping, and Vermin Destroying), 47 (Plant Husbandry), 56 (Harvesters), 99 (Foods and Beverages: Apparatus), 111 (Planting), 119 (Animal Husbandry), 131 (Tobacco), 426 (Food or Edible Material: Processes, Compositions, and Products), 449 (Bee Culture), 452 (Butchering), and 460 (Crop Threshing or Separating). Most patented technologies in agricultural mechanization fall into one of these classes. For instance, McCormick's mechanical reaper (Patent No. 5335) and Knowles and Bevington's mower (Patent No. 7475) both belonged to patent class 56; Urmy's seed planter (Patent No. 8866) belonged to patent class 111; Murdock's tobacco cutter (Patent No. 11330) belonged to patent class 131; Dozier's threshing machine (Patent No. 5050) belonged to patent class 460.

[19]For instance, Moser (2012) examines evidence from World's Fairs and finds that only a fraction of new British technologies displayed at the Crystal Palace Fair was patented. Olmstead and Rhode (2008) show that new varieties of cotton seeds were associated with major advances in picking rates, but patents did not protect the new seeds.

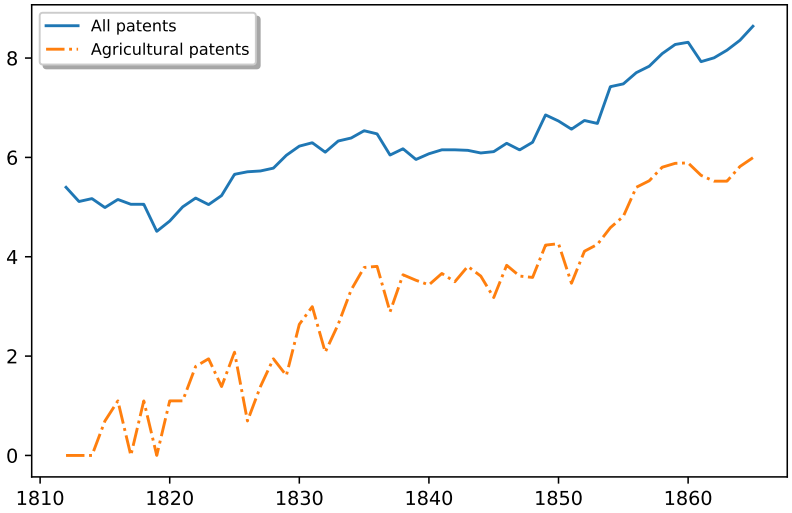


Figure 2. Number of patents granted per year. The blue curve shows the natural logarithm of one plus the total number of patents granted by year for 1812–1860. The orange dashed curve shows the natural logarithm of one plus the total number of agricultural patents granted by year for 1812–1860.

the alternative economic census data were available only at the decennial frequency.[20] Studies have shown a strong correlation between patenting and the resources consumed in inventive activity (see Griliches (1990) for a survey). Sokoloff (1992) uses census data and shows that patenting was a major driver of state-level total factor productivity in the antebellum era. Nanda and Nicholas (2014) examine the quantity and quality of patenting to measure innovation during the Great Depression. Despite not protected by patents, new cotton seed varieties did not belong to labor-saving technologies (which increase the productivity of capital disproportionately relative to labor) and thus would not bias our analysis of the role of labor practices.

3.3 Measuring Labor Exploitation

The antebellum practice of slavery led to exploitative labor practices. The pervasiveness of labor exploitation differed across states and shaped the local cost of labor in agricultural production. To measure the extent of labor exploitation, we construct the variable, *Labor exploitation*, as the fraction of a state's (county's) population that was enslaved when the state entered the antebellum era. We use the time-invariant fraction of the initial enslaved population to isolate it from changes in the enslaved population in response to local financial development. If a state or territory did not have population data reported in the 1810 census,

[20] Although better metrics have been developed for modern-day patents to capture the economic value of innovation, such as citation and market value, neither information is available for antebellum patents.

we instead use the first year when the demographic data are available.[21] Among the 39 states in our sample, 28 states had positive *Labor exploitation*; see Table A.1 in the Online Appendix. Of these 28 states, 17 had legal systems that sanctioned slavery. The top five states with the highest *Labor exploitation* were South Carolina, Louisiana, Florida, Mississippi, Georgia, which remained among the states with the highest fractions of enslaved population in 1860. Among the other 11 states—as in New Jersey and Illinois—slavery had been abolished but the existing enslaved population had to remain with their former owners, and the fractions of populations enslaved were small.

3.4 Sample Construction and Summary Statistics

Our sample period spans from 1812 through 1860. For states established after 1812, they enter our sample starting from the year of establishment as a territory or statehood, whichever is earlier.[22] To control for demographic and socioeconomic conditions at the state and county level, we obtain information from the decennial censuses of 1810–1860 and the Census of Agriculture in 1840, 1850, and 1860. We use the following set of baseline control variables: Ln(*Population*) defined as the natural logarithm of a state's (county's) population, *Urban ratio* defined as the fraction of population that was urban, and *White ratio* defined as the fraction of population that was white. The definitions of all variables are provided in Appendix A. In our robustness analyses, we also include characteristics related to industry composition, educational attainment, foreign-born fraction of the population, and access to railroads. Since the control variables are decennial, we interpolate them linearly to the intervening individual years. Our sample consists of 1,449 state-year observations and covers 39 states.

Table 2 reports the descriptive statistics for our sample. On average, a state in our sample had 25.48 total patents and 1.83 agricultural patents granted per year. Since both total patents and agricultural patents are right skewed, we take the log transformation to reduce the effects of outliers. The average population in a state was 0.57 million, of which 12.7% was urban population and 81.8% was white population. *Labor exploitation* for the state-year sample has a mean of 14.8%, a median of 4.4%, and a standard deviation of 17.1%, suggesting substantial differences in the fractions of populations enslaved across states. Because *Labor exploitation* is based on the demographic information when a state entered the antebellum era, it

[21] Our results are robust to using the contemporaneous measures of the fraction enslaved; see Table A.6 of the Online Appendix. In Section 5.3, we will examine plausibly exogenous variations in *Labor exploitation* using the fraction of a county's enslaved population that died of cholera in 1850.

[22] Online Appendix Table A.1 provides the list of states and the year of territory/statehood. The date of statehood information is obtained from www.history.com/topics/us-states.

is not time-varying. Of the 39 states in our sample, 28 had non-zero *Labor exploitation*. This variable is greater than 5% in 16 states, all of which were states that allowed slavery.

[Table 2 about here]

In an average state, there were 3.66 free banks, $2.07 million in free bank assets, and $1.47 million in loans issued by all free banks per year. Of those state-years that adopted free banking, there were an average of 30.28 free banks, which together had assets valued at $17.14 million and issued a statewide average of $12.19 million in loans each year. For those same observations, there were an average of 34.06 charter banks, which together had assets valued at $28.50 million and issued a statewide average of $18.84 million in loans each year.

4 Free Banking and Innovation

4.1 Identification Strategy

We use a difference-in-differences approach to assess the extent to which improved access to finance affected innovation. Our identification strategy requires that the enactment of the free banking laws imparted a positive shock to a state's access to finance. We begin by empirically testing how the timing of free banking in a state was related to potential determinants of innovation. Using a hazard model, we predict the "time until the law's passage" with a diverse set of variables. Besides state-level demographic characteristics and wage rates, we also include variables to measure the pre-event conditions of innovation and banking development in a state, which could potentially confound the causal impact of free banking on innovation.[23] Another factor possibly related to both innovation and banking is the alternation of state political parties in power. For example, the Whig Party favored modernization, banking, and economic protectionism to stimulate manufacturing.[24] We additionally include measures of industry composition, educational attainment, and access to railroads. Estimations of the hazard model, reported in Table A.2 in the Online Appendix, show that none of these variables significantly predict the likelihood of the law's passage in a specific year. Notably, free banking spread through each region of antebellum America. It was not an exclusive feature of the industrial North, nor was it associated with the pervasiveness of slavery in a state. This test lends

[23] We include the variable *Labor exploitation* to alleviate the concern that the practice of slavery might have affected the adoption of free banking. Results are unchanged if we use *White ratio* instead of *Labor exploitation*.

[24] The Whig Party, consisting of former members of the National Republican and Anti-Masonic Parties, emerged in the 1830s as the leading opponent of Jacksonians (supporters of President Jackson and his Democratic Party).

strong support for the historical narrative in Section 2.2 that the passage of the free banking law by a state was plausibly an exogenous event.

Next, we provide evidence that the adoption of free banking indeed accelerated bank entry and improved access to finance. Panel A of Table 3 reports the entry of free banks within three years following the law's passage in the 18 free banking states. We observe substantial free bank entry reflected in bank counts, assets, as well as in loans and discounts. On average, there were 19 free bank entries per state within three years following the law's passage, accounting for more than three times the number of banks operating in years before free banking. While the southern banking sector was considered smaller and had higher barriers to entry due to the preexisting bank branch networks serving plantation owners (Calomiris and Schweikart, 1991), we observe significant bank entry in those states as well. For example, Tennessee had 16 free banks adding to its five existing charter banks, Louisiana had four banks adding to its six existing charter banks, and Alabama had one bank adding to its sole existing charter bank.

[Table 3 about here]

The notion of improved access to finance was particularly relevant as banking markets were local. Examining the county locations of the entrants, we find that the new banks entered rural, previously unbanked areas, and had broader geographical coverage than the existing charter banks. After the onset of free banking, 21.7% of previously unbanked counties had bank entry, and 18.5% of previously unbanked counties had free bank entry by 1860.

To rule out the possibility of capital reallocation from charter banks to free banks, we assess how free banking affected a state's access to finance in Panel B of Table 3. As expected, the free banking laws allowed sizable free bank entry. More importantly, charter banks did not exit the market or become smaller. These results confirm that the banking sector as a whole expanded, and that access to finance improved following the adoption of free banking laws.

4.2 Baseline Analysis

We test the first hypothesis—improved access to finance leads to more innovation—using the following ordinary least squares (OLS) specification:

$$Ln(1 + Patents)_{i,t+s} = \alpha + \beta Free\ banking_{i,t} + \gamma Z_{i,t} + State_i + Year_t + \epsilon_{i,t}, \quad (1)$$

where i indexes state, t indexes year, and s is equal to one, two, or three years. The dependent variable is the natural logarithm of one plus the total number of patents granted in a state in the following one, two, and three years. The dummy variable, $Free\ banking_{i,t}$, captures the status of the law's passage in state i and year t. Z is the vector of state-level control variables (Ln(*Population*), *Urban ratio*, and *White ratio*). $State_i$ and $Year_t$ are state and year fixed effects, respectively. We cluster standard errors by state to account for serial correlation within states.[25]

The state-level control variables help absorb the time-varying socioeconomic conditions that were possibly associated with a state's inventive opportunities. We include population size and urbanization following Higgs (1971) who shows that, in the absence of a mass communications system, the number of inventions per capita was closely associated with the proportion of population in urban areas. The white population ratio largely reflected the local social class structure, educational attainment, and division of labor. The state fixed effects allow us to strip out unobservable differences that persist across states; the year fixed effects enable us to control for economy-wide shocks and trends.

[Table 4 about here]

The estimation results are presented in Table 4. The coefficient estimates of *Free banking* are positive and significant at the 1% level across all columns. Consistent with hypothesis 1, the results indicate that the passage of free banking law led to an increase in the number of patents in the subsequent three years. For instance, based on the coefficient estimate in column (6), those states that passed the free banking law experienced a growth rate of 47.6% in total patents in the third year, compared to states that did not pass the law. This estimate translates to an increase of 12.13 (=25.48×47.6%) patents, given an average of 25.48 patents granted in a state each year. This increase in patent quantity is economically sizable, accounting for 16.1% (=12.13/75.23) of the state-level patent variability.

The estimated sizable effect of free banking on innovation might work through both *direct* and *indirect* channels. Through direct channels, free banks entered areas that previously lacked access to financial services, made loans to "non-insiders" who did not have connections to charter banks, and encouraged manufacturing and small businesses (Bodenhorn, 2000). As noted earlier in Section 2.2, Bodenhorn (1999) provides micro-level evidence of the Black River Bank and shows that this free bank operated as an innovation-inducing Schumpeterian bank by directly supporting young, local innovators and entrepreneurs.

[25] To investigate potential bias in these standard errors due to the small number of clusters, we perform the wild bootstrap procedure following Cameron et al. (2008) and find robust results.

Also, free banks might have promoted innovation through indirect channels. The lower barrier to entry by free banks made incumbent charter banks more efficient and competitive (Bodenhorn, 1990; Carlson et al., 2020), improving the allocation of bank capital (Rockoff, 1974). By examining the expansion of railroads and banks, Atack et al. (2014) show that banks generated a virtuous cycle of economic development through the transportation revolution. Consistent with this view, we find (in untabulated results) that free banking increased money supply and promoted the diffusion of railroad transportation networks, which likely enlarged market access and boosted incentives to innovate.

Whereas Table 4 shows that the effect on innovation started to be significant after one year, we believe this immediate effect is plausible for the antebellum era for several reasons. First, antebellum innovations typically did not take too long to invent. For instance, Singer developed the first practical sewing machine 11 days after being given a sewing machine to repair. Second, unlike today, examining and granting a patent took only several months. Finally, it was likely that the manufacturers of new tools and technologies were more sensitive to access to finance than inventors; when manufacturers had better financing, inventors had stronger incentives to patent existing ideas and inventions.

4.3 Robustness of the Baseline Results

Temporal dynamics. A relevant concern is reverse causality if states differed in their innovation intensity and if such differences triggered the passage of free banking laws. To alleviate this concern, we examine the dynamics of innovation surrounding the adoption of free banking. Specifically, we estimate an augmented version of equation (1) where we decompose *Free banking* into four dummy variables associated with four periods around the enactment: all years up to and including one year prior to free banking, one to two years after free banking, three to four years after free banking, and five years or more after free banking. The year in which the free banking law was passed is the reference year.

As reported in column (1) of Table A.3 in the Online Appendix, our estimates suggest that the change in innovation did not occur before the enactment of the free banking law. After the enactment year, the estimate becomes positive and significant, consistent with our baseline findings that the effect of free banking began to manifest one year after. In column (2), we decompose the period of five years or more after free banking into five to six years after free banking and seven years or more after free banking, and find the coefficient estimates virtually unchanged. To visualize the temporal dynamics, we further extend the time dummy variables up to 13 years before and seven years after free banking and plot the estimated coefficients in

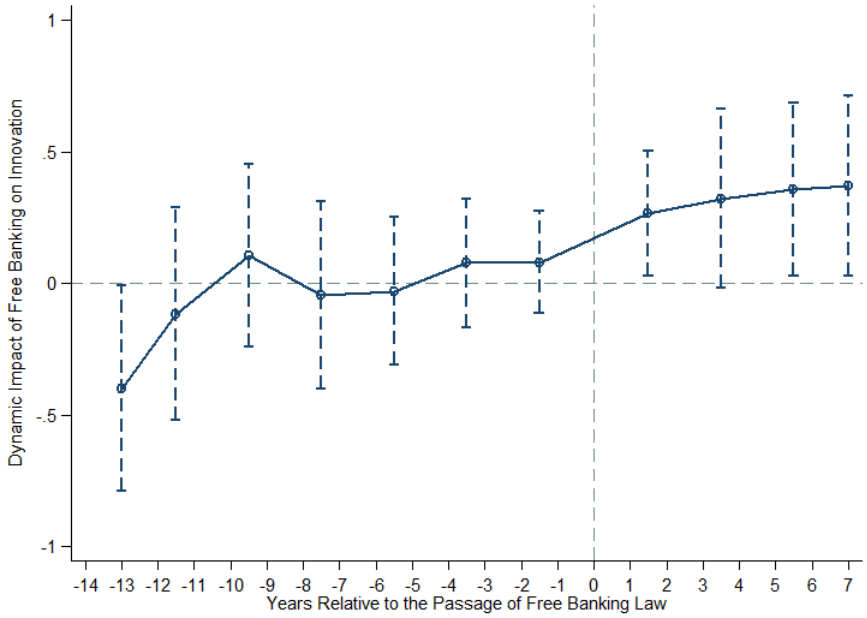


Figure 3. Temporal dynamics of innovation. This figure plots the point estimates for leading and lagging dummy variables of *Free banking* in the following model: $Ln(1 + Patents)_{i,t+1} = \alpha + \beta_1 Before_{i,t}^{13-} + \beta_2 Before_{i,t}^{12\&11} + ... + \beta_7 Before_{i,t}^{2\&1} + \beta_8 After_{i,t}^{1\&2} + ... + \beta_{11} After_{i,t}^{7+} + \gamma Z_{i,t} + State_i + Year_t + \epsilon_{i,t}$. $Before_{i,t}^{13-}$ is set to one for all years up to and including 13 years prior to free banking and zero otherwise. $After_{i,t}^{7+}$ is set to one for seven or more years after free banking and zero otherwise. $Before_{i,t}^{p\&q}$ is set to one for p to q years prior to free banking and zero otherwise. $After_{i,t}^{p\&q}$ is set to one for p to q years after free banking and zero otherwise. The vertical bars correspond to 95% confidence intervals with state-clustered standard errors.

Figure 3. We examine a shorter horizon for post-event because a majority of the states passed the free banking law in the last decade of our sample period. The figure corroborates a key message: effects on innovation did not precede free banking but persisted over the years following the law's passage.

Placebo test using randomized free banking years. To address the concern that an omitted variable coinciding with free banking events might drive our results, we perform a placebo test. We randomly assign a false free banking passage year to each state by maintaining the true distribution of the free banking years and re-estimate column (6) of Table 4. We repeat this procedure a thousand times and obtain the empirical distribution of the coefficient estimate on *Free banking*. As shown in Figure 4, the true coefficient estimate (0.476) is well above the 99th percentile of the distribution. This placebo test gives confidence that our estimated effect on innovation is not obtained randomly or driven by omitted shocks other than the passage of free banking laws.

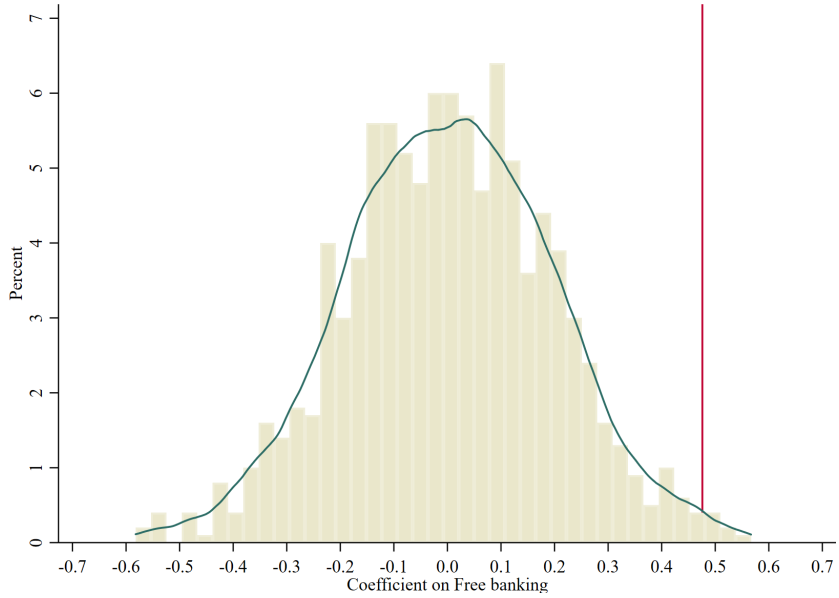


Figure 4. Placebo test of free banking on innovation. This figure plots the kernel density of the coefficient estimate on *Free banking* when we re-estimate column (6) of Table 4 one thousand times using the bootstrapped sample. We draw a vertical line to indicate the actual coefficient of 0.476 in column (6) of Table 4.

Poisson regression. Since the patent data are right skewed, we follow the common practice in the literature and take the log of one plus the patent count to reduce the effects of outliers. In column (1) of Table A.4 in the Online Appendix, we evaluate the robustness of our results by estimating a Poisson regression model. The results show that the coefficient estimate on *Free banking* remains positive and significant. In column (2) of Table A.4, we show that our results are robust to the inclusion of state-specific pre-trends.

Subsample analyses. We assess the robustness of our baseline results in subsamples. First, to rule out the concern that relatively small variation in patenting might have an outsized effect on the growth rate of innovation, we exclude the state-year observations with zero patents. Second, the Second Bank of the United States, which operated from 1816 to 1836, had 25 branches scattered around the country and provided banking services to several states. To ensure that our results are not driven by the Second Bank's exit, we restrict to the post-Second Bank period. Third, a wave of passage of free banking laws occurred in the 1850s. We thus drop the states that had earlier adoption of free banking and start our sample from 1850. Fourth, studies have shown that free banks might have experienced a higher probability of failure than charter banks, especially in Michigan, Indiana, Illinois, Wisconsin, Minnesota, and New Jersey. We therefore exclude these so-called "wildcat banking" states (Rockoff, 1974). Finally, we exclude states in

the west because their establishment of territory/statehood was in the later part of the antebellum era. The results, reported in columns (3)–(7) of Table A.4 in the Online Appendix, show that the coefficient estimate on *Free banking* remains significant for these subsamples.

Controlling for contemporaneous laws. Another concern is that our estimates may capture the effect of other state laws instituted at the same time as free banking laws. For example, states used usury laws to limit the maximum interest rate banks could charge on loans. Benmelech and Moskowitz (2010) show that usury laws in the nineteenth century reduced credit and economic activity when they were binding. If the states that passed the free banking law concurrently relaxed the maximum interest rate, our results might be biased because a higher ceiling might allow banks to lend with lower restrictions to high-risk entrepreneurs. In addition, some states adopted general incorporation statutes for manufacturing firms, which might have an impact on innovation. In columns (8)–(9) of Table A.4 in the Online Appendix, we find that controlling for these contemporaneous law changes does not subsume the estimated impact of free banking on innovation.

Placebo test using the intensity of free banking activities. Among the 18 states that passed the free banking law, 11 (including New York and Louisiana) had significant free banking activities, whereas little free banking activities materialized in Massachusetts, Pennsylvania, Alabama, Florida, Iowa, Georgia, or Vermont (Rolnick and Weber, 1983). This observation provides us with a natural spectrum of the intensity of free banking activities. If the estimated effect of free banking indeed comes through its impact on access to finance, it should be more pronounced in the 11 states with significant free banking activities, and less pronounced in the seven states with little free banking activities. This is indeed what we find in Table A.5 in the Online Appendix.

4.4 County-Level Identification

Antebellum banking markets were local due to the high transportation cost; hence, we expect that the entry of free banks had a significant impact on local innovation outcomes. To estimate the relation between access to free banks and local innovation outcomes, we next turn to our county-level sample, which consists of 51,585 county-year observations and covers 2,007 unique counties. Specifically, we regress the patenting outcomes on the counts, assets, and loans of free banks located in a county, and use the set of county-level control variables same as in Table 4, including county and year fixed effects. The results, reported in columns (1)–(3) of Table 5, suggest that the degree of access to free banks in a county was significantly

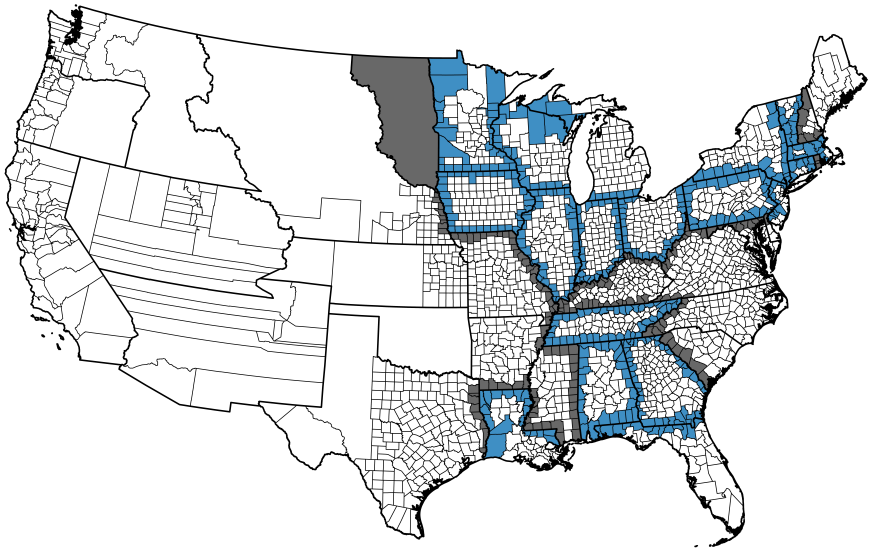


Figure 5. Contiguous border counties of the free banking states in 1860. This figure illustrates the contiguous border counties for the identification test reported in columns (4)–(6) of Table 5. The "treated" counties inside the free banking state border are illustrated in blue, and the "control" border counties are illustrated in gray. As the county and state boundaries are time-varying, we demonstrate the sample using the GIS files based on the 1860 census.

associated with patent counts three years ahead. For instance, the coefficient estimate of column (1) implies that for a 1% increase in the number of free banks in a county, the number of patents increased by 0.36% in the third year.

[Table 5 about here]

The entry of free banks in a county, however, might be endogenous to local economic conditions. To address the potential endogeneity bias, we employ an identification strategy that compares contiguous counties separated by state borders (Huang, 2008; Heider and Ljungqvist, 2015). Specifically, we include counties along a shared state border, where the free banking law was passed on one side. By restricting the control group to contiguous counties in close geographical proximity on the other side of the state border, we can effectively remove the biasing influence of otherwise unobservable variation in local economic conditions. We rely on the GIS files provided by the National Historical Geographic Information System (2020) to identify the contiguous border counties based on the time-varying county and state boundaries. The contiguous border county sample consists of 16,526 county-year observations and 574 unique counties. Figure 5 illustrates the "treated" counties inside the free banking state border and their "control" border counties based on the 1860 census.

In columns (4)–(6) of Table 5, we re-estimate the OLS regressions using the contiguous border county sample. Besides county and year fixed effects, our specification also includes border fixed effects in order to focus the comparison between contiguous counties around a specific state-pair border instead of between those that were not located in neighboring states. The coefficient estimates on the county-level access-to-bank measures continue to be positive and statistically significant at the 1% level, and are comparable in magnitude to those estimates using the full sample. This test provides confidence that unobserved local confounds do not drive the positive relation between innovation and access to finance. Overall, our county-level results are potent evidence that free banks entered counties that previously lacked access to finance and positively influenced local innovation outcomes.

5 Labor Practices and the Finance-Innovation Nexus

Our evidence so far shows a robust and positive effect on technological innovation from improved access to finance. This section extends our analysis and shows that both access to finance and labor practices are critical factors that drive innovation outcomes. Whereas improved access to finance in general fosters innovation, its extent varies in predictable ways with local labor practices.

5.1 Exploitative Labor Practices and Agricultural Innovation

Antebellum America provides a suitable empirical context to study the role of labor practices. The labor markets were more geographically segmented than today's markets, and there was considerable divergence in the practice of slavery across regions. Enslaved workers, providing the major agricultural labor in Southern states, faced pronounced exploitation. Because of their property rights, planters were able to extract a substantial share of enslaved labor's marginal product, paying a low maintenance cost. In comparison, in regions without an enslaved population, farmworkers had property rights in their own labor, and farmers had to pay wages more or less equal to labor's marginal product. Such spatial variation in the practice of slavery represents a natural heterogeneity in the intensity of labor exploitation, which shaped the cost of agricultural labor and affected producers' demand for agricultural machinery.

Hypothesis 2 predicts a negative cross-sectional relation between the intensity of labor exploitation and the sensitivity of innovation to finance. To the extent that economizing on labor costs posed a major concern, producers facing a higher cost of labor would be more inclined to switch to machines. Improved access to finance made investments in agricultural machinery more feasible and thereby increased the demand for

labor-saving technologies. However, producers using exploitative labor practices faced a marginal cost of labor lower than the marginal product and had little incentive to shift away from labor-intensive production methods. Accordingly, we expect that the passage of the free banking law had a weaker impact on agricultural innovation in regions where exploitative labor practices were more pervasive.

We test hypothesis 2 by augmenting equation (1) with the variable *Labor exploitation*, which measures the pervasiveness of exploitative labor practices in a state (county). The model is as follows:

$$Ln(1 + Agricultural\ patents)_{i,t+s} = \alpha + \beta_1 Free\ banking_{i,t} \times Labor\ exploitation_i + \beta_2 Free\ banking_{i,t} + \gamma Z_{i,t} + State_i + Year_t + \epsilon_{i,t}, \quad (2)$$

where i indexes state, t indexes year, and s is equal to one, two, or three years. The dependent variable is the natural logarithm of one plus the total number of agricultural patents granted in a state in the following one, two, and three years. We focus on agricultural patents because, as noted earlier in Section 3.3, the labor-saving incentive and the spatial variation in labor exploitation were manifested primarily in agriculture. The dummy variable, $Free\ banking_{i,t}$, captures the status of the law's passage in state i and year t. To interact with *Free banking*, we introduce the variable $Labor\ exploitation_i$, defined as the fraction of state i's population that was enslaved when the state entered the antebellum era.[26] The coefficient on the interaction term β_1 reflects the correlation between labor exploitation and the sensitivity of agricultural innovation to free banking. If labor exploitation is negatively associated with the impact of free banking on agricultural innovation, we expect β_1 to be negative.

[Table 6 about here]

Columns (1)–(3) of Table 6 summarize the results estimating equation (2). The coefficient estimates of *Free banking* are positive and significant at the 1% level, suggesting that free banking spurred agricultural innovation in states with no enslaved population. Consistent with hypothesis 2, the estimates for β_1 in all columns are negative and statistically significant at the 1% level. Based on the estimate in column (3), states with a median *Labor exploitation* of 4.4% had 87.1% (=102.4%−3.48×4.4%) more agricultural patents three years after the law's passage, and as *Labor exploitation* increases by one standard deviation (17.1%) from the median, states with *Labor exploitation* of 21.5% had 27.6% more agricultural patents

[26] We do not include $Labor\ exploitation_i$ separately in the model because it is not time-varying and thus is subsumed by the state fixed effects. As shown in Table A.6 of the Online Appendix, our results are robust to measuring *Labor exploitation* alternatively as the contemporaneous fraction of a state's population that was enslaved in a given year.

three years after the law's passage.

A possible explanation for the observed negative association between labor exploitation and the finance-innovation nexus is the modest entry by free banks in areas with more pervasive labor exploitation (the Southern states). If the results are driven solely by the limited bank entry in those areas, we should not expect a differential impact on innovation across regions conditional on the same level of bank entry. Therefore, instead of using a dummy variable that captures the extensive margin of free banking at the state level, we perform county-level regressions using the free bank counts of a county to capture the intensive margin.

We report the county-level regression results in columns (4)–(6) of Table 6. The coefficient estimates on Ln(1+*Free bank counts*) × *Labor exploitation* remain negative and statistically significant, suggesting that the marginal value of an additional bank decreased with the intensity of labor exploitation. This finding bolsters confidence that exploitative labor practices negatively correlated with the impact of finance on agricultural innovation, controlling for the level of entry by free banks in a county.

Another concern is that areas with different degrees of labor exploitation also differed in economic conditions and industry composition, and that these factors, rather than differences in exploitative labor practices, could potentially drive our results. For example, states in the South dominated in agricultural production but fell behind in innovation growth, the supply of immigrants, and access to railway transportation. Accordingly, we control for a diverse set of state-level characteristics, including industry composition, educational attainment, the foreign-born fraction of the population, innovation growth, and access to railroads. Specifically, we add these state-level characteristics and their interactions with the *Free banking* dummy as controls in estimating equation (2). The results, as reported in Panel A of Table 7, confirm that our findings continue to hold when controlling for these potential confounding factors.

[Table 7 about here]

We next isolate common sources of heterogeneity by examining subsamples of similar attributes. First, we remove states with no enslaved population (*Labor exploitation* = 0) from the analysis because their unobservable characteristics may differ from those of regions with exploitative labor practices. Second, to reduce industry heterogeneity, we exclude states in the Northeast, where manufacturing, rather than agriculture, experienced rapid growth and became the leading employer (Goldin and Sokoloff, 1982). Third, since the majority of enslaved laborers worked in the cotton fields, we restrict the sample to the states with positive cotton output using data from the Census of Agriculture. The results, reported in columns

(1)–(3) in Panel B of Table 7, show that the coefficient estimates on *Free banking* × *Labor exploitation* remain negative and statistically significant at the 1% level. Similarly in columns (4)–(6), we repeat the subsample analyses using county-level observations and by replacing the statewide banking shock, *Free banking*, with the county-level access to free banks, Ln(1+*Free bank counts*). The results suggest a robust negative relation between *Labor exploitation* and the sensitivity of patenting to access to local free banks, which is not a byproduct of heterogeneity bias.

In sum, our results in Tables 6–7 show that the impact of greater access to finance on innovation varied in a theoretically predictable manner. When focusing on the agricultural sector where the marginal cost of labor differed across states with different labor practices, we find a significantly weaker impact of free banking on agricultural patents in areas with more severe labor exploitation. Exploitative labor practices reduce labor's marginal cost relative to its marginal product and discourage producers from adopting labor-saving technologies, thus weakening the finance-innovation nexus.

5.2 Economic Mechanism: Changes in the Marginal Cost of Labor

Estimates in Table 6 imply that free banking might have depressed agricultural innovation in states where slavery was widespread. Take a state from the 75th percentile of *Labor exploitation*, where the enslaved population ratio was 30.4% in 1810. Our estimate shows that agricultural patenting fell by 3.4% (=102.4%−3.48×30.4%) in the third year after the law's passage relative to states that did not pass the law. Next, we show that this result is consistent with our hypothesis 3, namely, the impact of finance on innovation might be negative if access to finance exacerbates the extent of labor exploitation.

The proposed mechanism is that finance may shift the marginal cost of labor and affect innovation through producers' demand for labor-saving technologies. The finance-innovation nexus strengthens with an increase in marginal labor cost but weakens—and can even break—with a decline in marginal labor cost. In the context of antebellum America, the use of available finance after free banking differed across regions depending on sectoral specialization and labor practices; consequently, the effect of free banking on marginal labor cost also differed across regions. For example, in states where labor exploitation was absent, banks led to more accessible financing for merchants and manufacturers; the industrial development drove up local labor demand and wage rates (Goldin and Sokoloff, 1982). Conversely, in states where exploitative labor practices were pervasive, planters' major investment and wealth were in the enslaved people (Wright, 2006, p. 60). Bankers participated in enslaved mortgages, which facilitated the investment and trade of

enslaved persons. Hence, access to finance likely aggravated the use of exploited workers and reduced the marginal cost of labor, discouraging the adoption of labor-saving technologies. We thus test hypothesis 3 by first examining how labor cost in states with different degrees of labor exploitation responded to free banking. Then, we focus on states that sanctioned slavery in discussing potential channels.

We draw from several sources for measures of daily cost of labor. The wage measures are from Margo and Villaflor (1987), who provide annual estimates of nominal daily wage rates for common laborers (*Common laborer wage*) and artisans (*Artisan wage*) at the census region level from 1820 to 1856.[27] To proxy for the daily cost of using an exploited worker, we use the nominal daily hire rate for an enslaved laborer (*Slave hire rate*) from Fogel and Engerman (1976a).[28] Motivated by the conceptual framework in Appendix B, we proxy for the average cost of labor in a state by constructing *Weighted laborer cost* (*Weighted artisan cost*) as the average of *Common laborer wage* (*Artisan wage*) weighted by the fraction of population that was free and *Slave hire rate* weighted by the fraction of population that was enslaved. We use the historical Consumer Price Index (CPI) by Officer and Williamson (2018) to convert the nominal values to real terms.

[Table 8 about here]

Table 8 presents the results on whether free banking had a differential impact on the cost of labor that is predictably determined by a state's labor practices. Columns (1) and (2) report results for *Common laborer wage* and *Weighted laborer cost*. The coefficient estimates are positive for *Free banking* and negative for *Free banking* × *Labor exploitation*. Based on the estimates, in a state from the 25th percentile of *Labor exploitation* (0.1%), *Common laborer wage* increased by 4.5 cents (=0.045−0.169×0.1%) the year after free banking relative to the non-free-banking states, which is 5.5% of the sample mean (81.7 cents). In a state from the 75th percentile of *Labor exploitation* (30.4%), *Common laborer wage* dropped by 0.8% of the sample mean and *Weighted laborer cost* dropped by 2.5% of the sample mean the year after free banking relative to the non-free-banking states. The larger decline in the latter variable indicates that the negative

[27] Antebellum wage records are scarce (e.g., wage rates from the censuses are decennial). The estimates from Margo and Villaflor (1987) are at an annual frequency and cover all parts of the country, providing the most comprehensive wage data for the antebellum labor markets.

[28] Ideally, one would like to directly measure the subsistence cost (food, clothing, medical care, housing, insurance, and supervision). Since detailed data on subsistence costs are not available, we measure the opportunity cost using data on the rate when enslavers hired out enslaved workers. As Wright explains, "it makes no essential difference whether the slave was owned or rented; the opportunity cost of labor was the same in either case" (Wright, 2006, p. 71). Data on the hire rate are available for eight Southern states, so we use observations for the eight states to fill in their bordering states within the same economic census division. When a state has multiple bordering states, we take the average across the neighboring states. For the few years with missing observations, we interpolate the data linearly.

impact of free banking on labor cost is driven primarily by the exacerbation of slavery. Results are similar in columns (3)–(4) where we replace the dependent variable in columns (1)–(2) with *Artisan wage* and *Weighted artisan cost*. These results suggest that free banking increased wage rates in areas without labor exploitation, and decreased the cost of labor in areas where exploitation was pervasive.

A decline in the daily cost of using an enslaved worker after free banking meant the enslaver could extract a larger share of the labor's marginal product, which drove up the value of an enslaved worker.[29] To test this prediction, we using data on *Slave sale value* from Fogel and Engerman (1976b) as the dependent variable in column (5) of Table 8. Consistent with our prediction, the coefficient estimate on *Free banking* × *Labor exploitation* is positive, suggesting that free banking increased the financial value of owning enslaved labor in regions with pervasive slavery.

We offer two channels for the decline in marginal labor cost in states with exploited workers after the free banking reforms. One channel is that free banking led to more widespread slavery in terms of both the numbers of people enslaved and the spread of enslavement. Consistent with this channel, column (1) of Table 9 shows an increase of 16.2 percentage points in the fraction of population enslaved after free banking. Moreover, column (2) shows that the percentage of those listed as holding enslaved workers (out of the white population) increased by 1.6 percentage points in the free banking states from 1850 to 1860. These findings are in line with studies documenting the interregional trade in enslaved people (Collins, 1904; Conrad and Meyer, 1958). Banks played a central role in assisting this trade throughout the antebellum era (Murphy, 2017b). Profit-seeking banks participated in underwriting the sale of enslaved persons, accepting them as collateral for mortgage loans and equity loans; banks also assisted in selling enslaved persons as part of foreclosure proceedings on those who failed to fulfill a debt contract. Alternatively, finance might have encouraged more planters to migrate (Fogel and Engerman, 1974), who then took enslaved workers with them to states that adopted free banking.

[Table 9 about here]

A second channel is the increased concentration of enslaved workers following the free banking law. Using data on the distribution of slaveholding from the 1850 and 1860 census, we show in columns (3)–(7) of Table 9 that slaveholding appears more concentrated after the adoption of free banking. The Gini

[29] Although many factors, such as market conditions and political uncertainty (Calomiris and Pritchett, 2016), might have affected the valuation of an enslaved person, a central determinant is the expected stream of cash flows generated from the marginal product of the enslaved labor net of the operating cost (Wright, 2006).

coefficient, which is a measure of concentration based on the distribution of slaveholding, increased after free banking, suggesting that larger plantations accounted for a higher proportion of the total enslaved population. A detailed breakdown of the distribution of slaveholding confirms a rise in the percentage of large plantations (e.g., with 100 or more enslaved persons) and a decline in the percentage of small plantations (e.g., with fewer than five enslaved persons). In other words, large plantations grew larger by the eve of the Civil war. Due to their economies of scale, larger plantations were associated with more efficient allocation of labor, more intense monitoring, and likely lower daily operating cost. Accordingly, those who owned larger plantations extracted a higher profit (marginal product of labor minus operating cost) and had less incentive to switch to labor-saving technologies. In fact, they probably had a disincentive toward producing such innovations, as the new technology would likely have reduced the value of their major asset—enslaved labor. These findings support the mechanism that free banking aggravated labor exploitation and reduced technical progress in agriculture.

We conclude this subsection by validating that free banking's negative impact was limited to agricultural patents in states heavily reliant on exploited labor. We compare within those states where labor exploitation was severe (*Labor exploitation* above the sample median) and estimate free banking's impact on agricultural patents relative to other patents in Table A.7 of the Online Appendix. The coefficient estimate on *Free banking* captures the effect of free banking on non-agricultural patents, and the coefficient estimate on *Free banking* $\times$ *Agriculture dummy* captures the incremental effect of free banking on agricultural patents. Estimates in column (3) show that, relative to the non-free-banking states, non-agricultural patents increased by 37.5% in year t+3 after free banking, but agricultural patents decreased by 29% (=−66.5%+37.5%). Consistent with hypothesis 3, these estimates suggest that in states where labor exploitation was severe, the positive effect of finance was isolated to innovations not substituting for exploited workers, and agricultural innovations actually reduced.[30]

Overall, the evidence in Tables 6–9 indicates that improved access to finance, on average, stimulated technological innovation, but its extent declined with the use of exploited workers. In response to easier bank entry under the free banking laws, states rife with labor exploitation were associated with exacerbated exploitation, a drop in the marginal cost of labor, and a reduction in agricultural patenting. When geared to

[30]This heterogeneous response across patent types also helps to rule out alternative explanations for the negative relationship between labor exploitation and the sensitivity of patenting to free banking. For example, states associated with exploitative labor practices might be less inventive because of intrinsic characteristics, such as conservative culture, social norms, lack of economic diversity, climate, major crops, or alternative credit sources. These factors alone, however, cannot rationalize the negative effect on agricultural patents and the positive effect on non-agricultural patents.

aiding slavery, the additional finance weakened planters' incentives to adopt labor-saving technologies.

5.3 Shocks to Labor Exploitation

To establish a causal role of the exploitative labor practices, we need to address the endogeneity of the variable *Labor exploitation*. Measuring *Labor exploitation* as the time-invariant fraction of the initial enslaved population alleviates concerns about reverse causality. In addition, our robustness tests in Section 5.1 substantially mitigate concerns about omitted variables. Still, to provide further causal evidence on the effect of labor practices on the marginal impact of free banking on innovation, in this section we examine two plausibly exogenous shocks to the supply of exploited workers.

The first shock is in the context of the 1850s cholera pandemic. This pandemic entered the United States in 1849 through New York and New Orleans, spreading across much of the country until 1854. Claiming hundreds of thousands of lives, this pandemic is among the largest loss-of-life events in US history.[31] Death could happen within a day, sometimes within a few hours of the abrupt onset of symptoms (Rosenberg, 2009). Deemed the "poor man's plague," cholera was confined mostly to the lower classes living in filth and poverty. Primitive sanitation practices, warm weather, and proximity to waterways by which ships carried the disease exacerbated the spread of disease, and the epidemic disproportionately affected enslaved field hands, causing sudden reductions in the enslaved population in affected regions (Hays, 2005). It has been calculated that the Southern states alone lost ten thousand enslaved people in 1849 (Rosenberg, 2009). The 1850s cholera pandemic thus generated a negative shock to the extent of labor exploitation by planters.

To measure the county-level exposure to the cholera shock, we hand-collect novel data from the 1850 Census Mortality Schedules via ancestry.com on the number of cholera-caused deaths among the enslaved population in a county in 1850.[32] The data are available for 722 counties in 12 Southern states. We limit the sample period to 1850–1860 since 1850 is the only antebellum year for which the mortality schedule is available. Because the pandemic lasted for about five years in the United States until 1854 (Rosenberg, 2009), we construct the variable *Enslaved cholera deaths* as the fraction of a county's enslaved population that died of cholera in 1850 for the years 1850–1854, and as zero for the years 1855–1860.

To leverage the county-level granularity, we use Ln(1+*Free bank counts*) to measure local access to free

[31] See the Deadliest American Disasters and Large-Loss-of-Life Events Website maintained by Wayne Blanchard.

[32] Taken concurrently with the 1850 Census, the 1850 Mortality Schedule presents a unique opportunity to observe the mortality among the enslaved population. The Mortality Schedule enumerated the individuals who died during the 12 months prior to the census day. It listed the deceased name, gender, age, race, marital status (if white), place of birth, month of death, occupation, and cause of death. The data are available at www.ancestry.com/search/collections/8756.

banks. Our goal is to examine whether access to free banks had a differential impact on local agricultural patenting in counties that were differentially exposed to the cholera epidemic in their enslaved population. As noted earlier, producers using fewer enslaved workers would be more inclined to switch to machines when finance became more accessible. Hence, if the effect of exploitative labor practices was indeed causal, we expect a greater increase in the demand for labor-saving technologies in areas harder hit by cholera.

[Table 10 about here]

Table 10 summarizes the results. Consistent with our prediction, estimates of the baseline regression in column (1) show that local agricultural innovation responded more positively to access to free banks in areas where planters faced larger *Enslaved cholera deaths*. In columns (2)–(4), we consider three alternative measures of *Enslaved cholera deaths* as robustness checks. Since the pandemic subsided after 1854, we report results by also including 1855 in the cholera years in column (2). To control for the mortality rate among enslaved workers, we alternatively calculate *Enslaved cholera deaths* as the fraction of a county's total enslaved deaths that were caused by cholera in column (3). Finally, cholera was not the only disease bringing death to America. We thus obtain a third measure for *Enslaved cholera deaths* in column (4) as the fraction of the enslaved population who died in 1850 from one of the eight major deadly and contagious diseases ubiquitous at the time, including cholera, measles, smallpox, tuberculosis, pneumonia, typhus, typhoid, and yellow fever. Our results are robust for all alternative measures. Overall, our evidence based on the 1850s cholera pandemic supports a causal interpretation of the relation between labor exploitation and the sensitivity of innovation to financial development.

Our tests regarding the effect of labor exploitation are focused on agricultural innovation because our strategy leverages the spatial variation in slavery, under which highly exploited enslaved people worked primarily in agriculture. To shed light on technological innovation more broadly, we next examine another group of highly exploited workers at the time—Irish immigrants.

Around two million Irish migrated to America from 1820 to 1860, constituting the largest share of antebellum immigrants (Willcox, 1929). Unlike other immigrants, the Irish came with no capital as they fled their homeland to escape starvation and religious persecution. These Irish immigrants often took any jobs they could find, at meager pay, and were largely exposed to exploitation by employers (Laxton, 1997). Newspapers reported that those who were employed in canals and railroad construction projects were treated "like slaves" (Wittke, 1939). As such, the arrival of Irish immigrants provided a positive shock to the extent

of labor exploitation by local producers.

To measure the influx of Irish immigrants to each state in each year, we construct a state-year variable, *Irish immigrants*, in two steps. First, we use data from Willcox (1929) on the annual aggregate flow of Irish immigrants into the United States from 1820 to 1860. The aggregates of immigrants by sending country were compiled from passenger lists provided by the masters of arriving vessels. Second, to estimate the arrival of Irish immigrants to each state, we employ a modified version of the shift-share instrument (Card, 2001) using the shares of persons born in Ireland in each state reported in the 1850 census (the first year when such information is available).[33] If an increase in the supply of workers vulnerable to exploitation weakened the incentive to shift away from labor-intensive production techniques, we expect free banking to have a weaker impact on innovation in states with greater arrivals of Irish immigrants.

[Table 11 about here]

Table 11 reports our results using the influx of Irish immigrants as a positive shock to labor exploitation. Our results indicate a significant and negative relation between the quantity of Irish immigrants' arrival and the sensitivity of innovation to the adoption of free banking. The findings are robust to using the extensive and intensive margin of free banking. This additional causal evidence based on Irish immigrants and overall patenting outcomes corroborates our idea that both access to finance and labor practices are critical factors in shaping innovation outcomes.

6 Conclusion

In this paper, we present new evidence of the finance-innovation nexus and establish the importance of labor practices in shaping this relation. Our testing ground is antebellum America from 1812 to 1860. This historical episode witnessed the staggered passage of free banking laws across 18 states, which offers us an opportunity to identify exogenous variations in local access to finance. In addition, the use of enslaved labor, which is widely and rightly condemned on moral and ethical grounds, provides a window through which to study the impact of exploitative labor practices on agricultural producers' incentives to adopt labor-saving innovations.

We show that greater access to finance, as identified by the staggered passage of free banking laws, stimulated innovation on average. However, access to finance alone was no guarantee of innovation. The

[33] This approach exploits the observation that immigrants locate close to settled immigrants from the same country of origin. It generates variation at the state level from changes in national inflows, which are arguably less endogenous to local conditions.

finance-growth nexus was more pronounced in areas where producers faced strong incentives to substitute innovative technologies for labor. In areas where producers relied extensively on exploitative labor practices, more accessible banking might have slowed agricultural innovation by exacerbating the exploitation and further dampening producers' incentives to cut labor costs. Our findings therefore contribute to existing studies by illuminating an important adverse effect of slavery on economic development.

This study advances our understanding of the factors that drive innovation. Although existing studies have explored the separate roles of finance and labor costs, little is known about how the two factors interact and jointly determine innovation outcomes. Our evidence suggests a novel mechanism through which finance can, directly and indirectly, impact innovation by influencing producers' incentives to replace labor with technology. While access to finance, in general, fosters innovation, our mechanism highlights scenarios in which finance may stifle innovation. Our findings thus generate new insights that can be used to develop policies that promote innovation. For example, if firms respond to a relaxation of financial constraints by expanding production and adopting more exploitative labor practices, innovation might decrease. Accordingly, targeted policies, such as government research grants (Howell, 2017) and tax incentives for research and development (Bloom et al., 2019), are likely more effective than general-purpose financial support.

Appendix A: Variable Definitions

Variable name	Description
Measures of innovation	
Ln(1+*Patents*)	The natural logarithm of one plus the total number of patents granted in a state (county) in a given year
Ln(1+*Agricultural patents*)	The natural logarithm of one plus the total number of agricultural patents granted in a state (county) in a given year. Agricultural patents consist of those that fall into technological category 61 (Agriculture, Husbandry, Food).
Agricultural dummy	An indicator variable that takes the value of one if the patent count in a state, Ln(1+*Patents: agricultural or non-agricultural*), is for agricultural patents and zero if it is for non-agricultural patents
Free banking events	
Free banking	An indicator variable that takes the value of zero prior to the passage of the free banking law and one otherwise. For Michigan, the variable was zero prior to 1837, one for 1837–1839, zero for 1840 through 1856, and one for 1857 and later years. For states that did not pass a free banking law, the variable takes the value of zero for the entire sample period.
$Before^{m-}$	An indicator variable that takes the value of one in all years up to and including m years prior to the free banking law's passage and zero otherwise
$Before^{p\&q}$	An indicator variable that takes the value of one in p to q years prior to the free banking law's passage and zero otherwise
$After^{p\&q}$	An indicator variable that takes the value of one in p to q years after the free banking law's passage and zero otherwise
$After^{n+}$	An indicator variable that takes the value of one in n or more years after the free banking law's passage and zero otherwise
Little free banking	An indicator variable that takes the value of one if *Free banking* equals one and the state had little free banking activities, and zero otherwise. Of the 18 states that adopted free banking, seven had only little activity by free banks.
Large free banking	An indicator variable that takes the value of one if *Free banking* equals one and the state had significant free banking activities, and zero otherwise. Of the 18 states that adopted free banking, 11 had significant or "large" levels of activity by free banks.
Baseline control variables	
Ln(*Population*)	The natural logarithm of the total population in a state (county) in a given year, from decennial census
Urban ratio	The ratio of urban population to total population in a state (county) in a given year, from decennial census
White ratio	The ratio of white population to total population in a state (county) in a given year, from decennial census

Measures of access to finance	
Ln(1+*Bank counts*)	The natural logarithm of one plus the total number of banks in operation in a state in a given year
Ln(1+*Assets*)	The natural logarithm of one plus the total dollar value of bank assets in a state in a given year. The value is obtained by summing over the total assets on individual bank's balance sheets.
Ln(1+*Loans*)	The natural logarithm of one plus the total dollar value of bank loans and discounts in a state in a given year. The value is obtained by summing over the loans and discounts on individual bank's balance sheets.
Ln(1+*Free bank counts*)	The natural logarithm of one plus the total number of free banks in operation in a state (county) in a given year
Ln(1+*Free bank assets*)	The natural logarithm of one plus the total dollar value of free bank assets in a state (county) in a given year. The value is obtained by summing over the total assets on individual bank's balance sheets.
Ln(1+*Free bank loans*)	The natural logarithm of one plus the total dollar value of free bank loans and discounts in a state (county) in a given year. The value is obtained by summing over the loans and discounts on individual bank's balance sheets.
Measures of labor exploitation and the cost of labor	
Labor exploitation	The fraction of a state's (county's) population that was enslaved at the beginning of the antebellum era. We use the ratio of enslaved population to total population in the 1810 census; if a state or territory did not have population data reported in the 1810 census, we instead use the first year when the demographic data are available.
Common laborer wage	The real daily wage rate for a common laborer in a state in a given year. The data are from Margo and Villaflor (1987), who construct nominal daily wage rates at the census region level from 1820 to 1856 using payroll records of the US military that report wages paid to civilian workers at forts located throughout the country. We convert nominal values to real terms using historical CPI (Officer and Williamson, 2018).
Artisan wage	The real daily wage rate for an artisan in a state in a given year. The data are from Margo and Villaflor (1987). We convert nominal values to real terms using historical CPI (Officer and Williamson, 2018).
Slave hire rate	The real daily hire rate for an enslaved laborer in a state in a given year. The source is Fogel and Engerman (1976a), who provide data pertaining to slave hiring transactions that occurred from 1775 to 1865 in eight Southern states: Virginia, Maryland, North Carolina, South Carolina, Louisiana, Tennessee, Georgia, and Mississippi. We convert nominal values to real terms using historical CPI (Officer and Williamson, 2018).
Weighted laborer (artisan) cost	The average of *Common laborer wage* (*Artisan wage*) weighted by the fraction of population that was free and *Slave hire rate* weighted by the fraction of population that was enslaved
Slave sale value	The real sale value for an enslaved person in a state in a given year (in thousand dollars). The source is Fogel and Engerman (1976b), who provide data pertaining to slave sales and appraisals that occurred from 1775 to 1865 in eight Southern states: Virginia, Maryland, North Carolina, South Carolina, Louisiana, Tennessee, Georgia, and Mississippi. We convert nominal values to real terms using historical CPI by Officer and Williamson (2018).

Measures of labor exploitation and the cost of labor (continued)	
Fraction enslaved	The fraction of a state's (county's) population that was enslaved in a given year, from decennial census
Percentage of slaveholders	The number of slaveholders divided by the white population in a state in a given year, from decennial census
Gini coefficient	The number of slaveholders are distributed across the following size bins (in the number of enslaved persons): 0–1; 2–4; 5–9; 10–19; 20–49; 50–99; 100–199; 200–299; 300–499; 500–999; 1000 and above. We use the midpoint of each bin to construct the Gini coefficient; slaveholders with more than 1000 enslaved persons are assumed to hold 1000 enslaved persons.
Enslaved cholera deaths	A variable that equals the fraction of a county's enslaved population that died of cholera in 1850 for the years 1850–1854, and zero for the years 1855–1860. We consider three alternative measures of this variable in Table 10.
Irish immigrants	The total number (in thousands) of Irish immigrants that arrived in a state in a given year. This variable is available from 1820 to 1860 and is constructed using the annual aggregate inflow of Irish immigrants into the US based on the shift-share instrument approach.
Additional state-level characteristics	
Innovation growth	The annual growth rate of the number of patents
Political party	An indicator variable that takes the value of one if the presiding party in a state was Whig or Republican and zero otherwise. The data are from the record of the governors of the states in *The Tribune Almanac and Political Register*.
Agricultural labor ratio	The ratio of agricultural labor to the sum of agricultural and manufacturing labor in a state in a given year, from decennial census
Agricultural output	The value of total agricultural output in a state in a given year, from decennial census
Manufacturing output	The value of total manufacturing output in a state in a given year, from decennial census
Agricultural output ratio	The ratio of agricultural output value to the sum of agricultural and manufacturing output value, from decennial census
Education	The number of students in academies, grammar schools, and universities or colleges, scaled by the total population in a state in a given year, from decennial census
Foreign-born ratio	The ratio of foreign-born population to total population in a state in a given year, from decennial census
Railway	The fraction of counties that had railway access in a state in a given year, from decennial census
Max rate	The maximum interest rate limit in a state imposed by usury laws, from Holmes (1892)
Incorporation law	An indicator variable that takes the value of zero prior to the passage of the general incorporation statutes for manufacturing firms and one otherwise. The variable resets to zero for states that repealed the laws and returns to one when the state reinstated the law. For states that did not pass the general incorporation laws, the variable takes the value of zero for the entire sample period. The chronology is from Hilt (2017).

Appendix B: A Conceptual Framework

To articulate the theoretical motivation for our hypotheses, we build a conceptual framework to understand how access to finance and labor practices shape innovation outcomes.

Environment. The economy has a monopoly entrepreneur and a representative final goods producer. The entrepreneur innovates and patents new technology, $\theta \in (0, 1)$, and manufactures tools or machines, q, that embody the patented technology. To fix ideas, suppose θ is the technology to automate the task of reaping crops, then q is the quantity of mechanical reapers.

The representative final goods producer combines labor $L \in (0, 1)$, technology θ, and machines q in production. The production function is given by $\alpha^{-\alpha}(1-\alpha)^{-1}F(L,\theta)^{\alpha}q^{1-\alpha}$, where $\alpha \in (0, 1)$ and the scalar, $\alpha^{-\alpha}(1-\alpha)^{-1}$, is included for convenient normalization following Acemoglu (2010). Function $F(L, \theta)$ is increasing in both arguments and concave with labor; technology and labor satisfy $\partial^2 F/\partial L\partial\theta < 0$, that is, technology and labor are substitutes, reflecting a choice between labor-intensive production and capital-intensive production. For analytical convenience, let us take the functional form $F(L, \theta) = \theta + (1-\theta)L^{\beta}$, with $\beta \in (0, 1)$, such that $\partial F/\partial\theta = 1 - L^{\beta}$, and $\partial F/\partial L = (1-\theta)\beta L^{\beta-1}$. Whereas better technology boosts the productivity of machines, the marginal benefit decreases with the amount of labor input. Intuitively, θ is a labor-saving technology that shifts tasks from labor to machines.

The producer faces a unit cost of machine, χ, set by the monopoly entrepreneur. The unit cost of labor, w, depends on the local labor practices. In a region without exploitative labor practices, a competitive wage, $\bar{w}$, is paid to workers for each unit of labor input. By contrast, in a region where exploitative labor practices prevail, for example, through producers' property rights over labor, producers can extract part of labor's marginal product. Denoting the exploitation rate by e, the unit cost of exploited labor is $\bar{w} - e$.[34] Let the fraction of labor subject to exploitation in a region be d, the weighted unit cost of labor is $w = (1-d)\bar{w} + d(\bar{w} - e) = \bar{w} - de$. All else equal, the weighted unit cost of labor w decreases with the fraction of labor subject to exploitation d, and the exploitation rate e.

With monopoly power, the entrepreneur manufactures machines that embody the patented technology.[35] Due to information frictions and transaction costs inherent in financing innovative activities, the entrepreneur incurs a cost, $C(\theta, \gamma)$, e.g., for research and development (R&D), constructing prototypes, marketing, and gathering information for demand. The parameter γ summarizes the entrepreneur's access to local finance. $C(\theta, \gamma)$ is increasing and convex with θ, decreasing with γ, and satisfies $\partial^2 C/\partial\theta\partial\gamma < 0$. To simplify the analysis, let $C(\theta, \gamma) = \theta^2/(2\gamma)$, so $\partial C/\partial\theta = \theta/\gamma$. This is a reduced-form approach to capture the idea that greater access to local finance reduces the marginal cost of innovation by relaxing the entrepreneur's financing constraint and lowering financing cost. Besides potentially relaxing the constraint to finance R&D or patent application, improved access to local finance may benefit an entrepreneur in

[34] Consistent with Ransom and Sutch (2001), in exploitative labor practices (such as slavery), a large part of labor's marginal product goes to the owner, giving rise to the exploitation rate. The unit cost of exploited labor to an owner, $\bar{w} - e$, includes providing basic necessities—food, clothing, shelter. This parsimonious model abstracts away from many aspects of slavery. See, e.g., Fogel and Engerman (1974), Ransom and Sutch (2001), and Wright (2006) for influential works on slavery and Barzel (1977) and Acemoglu and Wolitzky (2011) for formal models of coercive labor markets.

[35] We assume the entrepreneur files the patent application and manufactures the machines. In practice, the innovator and the manufacturer could be different persons; nonetheless, the two activities are closely connected. For patent filing to be profitable, there must be a corresponding product market and an interested manufacturer for the technology. If greater access to finance makes the manufacturers more willing to invest, patenting promises greater profits, and innovators would become more willing to file patents and earn a royalty. One example is Walter Hunt, discussed in Section 2.1. Hunt sold the patent for the safety pin to W. R. Grace and Company, who mass-produced the safety pin and made millions.

several other ways. For instance, with a banker in town, the entrepreneur may face lower financing cost for manufacturing the new machines; she may also find it easier to acquire information and to market the new technology. Once the technology is patented, the entrepreneur has monopoly power and charges a monopoly price, χ, for each machine. To capture the non-rivalrous character of the technology, we assume that the machines can be produced at a low per-unit cost, normalized to $1-\alpha$.

Optimization. Given the unit cost of machine χ and the unit cost of labor w, the final goods producer chooses factor demands to maximize profit, i.e.,

$$\max_{q,L} \alpha^{-\alpha}(1-\alpha)^{-1}F(L,\theta)^{\alpha}q^{1-\alpha} - wL - \chi q. \tag{B1}$$

Taking the first-order conditions with respect to q and L, we obtain that the demand for machines satisfies $q^* = \alpha^{-1}F\chi^{-\frac{1}{\alpha}}$, and the demand for labor satisfies $(1-\alpha)^{-1}\chi^{1-\frac{1}{\alpha}}\frac{\partial F}{\partial L} = w$. Since F is increasing and concave with L, we have $\partial L^*/\partial w < 0$, that is, the demand for labor decreases with its cost.

Given the demand for machines and the cost of manufacturing the new technology, the monopoly entrepreneur chooses the level of technology θ and the monopoly unit price χ:

$$\max_{\theta,\chi} (\chi - (1-\alpha))\, q - C(\theta,\gamma) \tag{B2}$$

Equilibrium definition. For given labor practices and labor cost of a local region, $(\bar{w}, d, e)$, an equilibrium consists of the factor demands of the final goods producer (q^*, L^*) and the entrepreneur's decisions (θ^*, χ^*), such that q^* and L^* solve the producer's problem (B1) given w, θ^*, and χ^*, and θ^* and χ^* solve the entrepreneur's problem (B2) given the demand for machine q^*.

Factors driving innovation. We start by substituting the demand for machines $q^* = \alpha^{-1}F\chi^{-\frac{1}{\alpha}}$ into the entrepreneur's problem (B2). A first-order condition with respect to χ gives the profit-maximizing price of the entrepreneur, $\chi^* = 1$. Substituting χ^* and q^* into (B2), we reduce the entrepreneur's problem to $\max_{\{\theta\}} F(L^*,\theta) - C(\theta,\gamma)$. The equilibrium innovation θ^* satisfies

$$\theta^* = \gamma(1 - L^{*\beta}). \tag{B3}$$

Testable predictions. The equilibrium θ^* equates the marginal cost of innovation with its marginal benefit. The marginal cost, θ^*/γ, is inversely related to access to finance. The marginal benefit, $1 - L^{*\beta}$, is negatively related to the equilibrium labor input, which in turn depends on the local labor practices. Accordingly, two factors—access to finance and local labor practices—jointly determine the equilibrium innovation outcomes. This stylized model delivers several testable predictions which provide theoretical motivation for our hypotheses.

Prediction 1. $\partial\theta^*/\partial\gamma > 0$.

Prediction 1 establishes the positive impact of access to finance on innovation outcomes. Since $L^* \in (0,1)$, equation (B3) implies that θ^* increases with γ, all else equal. Greater access to finance shifts the marginal cost of innovation downward, leading to more innovation.

Prediction 2. *$\partial\theta^*/\partial\gamma$ increases with the competitive labor cost $\bar{w}$, decreases with the fraction of labor subject to exploitation d, and decreases with the exploitation rate e.*

Prediction 2 shows that the marginal impact of access to finance on innovation depends on local labor practices. Equation (B3) suggests that the impact of finance on innovation, $\partial\theta^*/\partial\gamma$, is negatively related to labor input L^*. From the producer's optimization problem, labor input decreases with labor cost w. Accordingly, the sensitivity of innovation to finance increases with labor cost w. Intuitively, in regions where higher unit cost of labor creates stronger incentives to replace labor, greater access to finance has a more substantial impact on labor-saving innovation. In our framework, the unit cost of labor depends on three terms: the competitive labor cost $\bar{w}$, the fraction of labor subject to exploitation d, and the exploitation rate e. For instance, we expect that in the cross section, the effect of finance on innovation is the greatest in areas where exploitative labor practices are absent, and the effect is weaker in areas with a larger fraction of exploited labor.

Prediction 3. *In areas where $d'(\gamma) > 0$ holds, the sign of $\partial\theta^*/\partial\gamma$ is ambiguous.*

Our baseline framework takes the labor practices of a region as fixed. Instead, prediction 3 considers a scenario when labor practices (thus the unit cost of labor) change with access to finance. The additional assumption, $d'(\gamma) > 0$, states that access to finance, besides reducing the marginal cost of innovation, also increases the fraction of labor under exploitation. This additional force, if significant enough, will break the positive link between finance and innovation. To see this, note that $d\theta^*/d\gamma = (1 - L^{*\beta}) + \partial\theta^*/\partial L \times \partial L^*/\partial d \times d'(\gamma)$. Equation (B3) suggests that $\partial\theta^*/\partial L < 0$, because an increase in labor input lowers the marginal value of labor-saving technology. From our earlier results, the demand for labor decreases with the cost w (recall that $w = \bar{w} - de$) and increases with the fraction of labor under exploitation d, that is, $\partial L^*/\partial d > 0$. Under the assumption that $d'(\gamma) > 0$, the last term above in $d\theta^*/d\gamma$ is negative. Especially if $d'(\gamma)$ is sufficiently large, it is possible that $d\theta^*/d\gamma < 0$. A similar prediction follows if $e'(\gamma) > 0$ holds. Prediction 3 highlights that the relation between finance and innovation becomes subtle when labor relations interact with access to finance.

References

Acemoglu, D. (2002). Technical change, inequality, and the labor market. *Journal of Economic Literature 40*(1), 7–72.

Acemoglu, D. (2010). When does labor scarcity encourage innovation? *Journal of Political Economy 118*(6), 1037–1078.

Acemoglu, D. and A. Wolitzky (2011). The economics of labor coercion. *Econometrica 79*(2), 555–600.

Acharya, V. and Z. Xu (2017). Financial dependence and innovation: The case of public versus private firms. *Journal of Financial Economics 124*(2), 223–243.

Amore, M. D., C. Schneider, and A. Žaldokas (2013). Credit supply and corporate innovation. *Journal of Financial Economics 109*(3), 835–855.

Atack, J., M. Jaremski, and P. L. Rousseau (2014). American banking and the transportation revolution before the Civil War. *Journal of Economic History 74*(4), 943–986.

Barzel, Y. (1977). An economic analysis of slavery. *Journal of Law & Economics 20*(1), 87–110.

Beck, T., R. Levine, and N. Loayza (2000). Finance and the sources of growth. *Journal of Financial Economics 58*(1), 261–300.

Bena, J., H. Ortiz-Molina, and E. Simintzi (2020). Shielding firm value: Employment protection and process innovation. Working Paper.

Benmelech, E. and T. J. Moskowitz (2010). The political economy of financial regulation: Evidence from U.S. state usury laws in the 19th century. *Journal of Finance 65*(3), 1029–1073.

Bidwell, P. W. and J. I. Falconer (1925). *History of agriculture in the northern United States, 1620–1860*. Number 358. Carnegie Institution of Washington.

Black, S. E. and P. E. Strahan (2002). Entrepreneurship and bank credit availability. *Journal of Finance 57*(6), 2807–2833.

Bloom, N., J. Van Reenen, and H. Williams (2019). A toolkit of policies to promote innovation. *Journal of Economic Perspectives 33*(3), 163–184.

Bodenhorn, H. (1990). Entry, rivalry and free banking in antebellum America. *Review of Economics and Statistics 72*(4), 682–686.

Bodenhorn, H. (1999). An engine of growth: Real bills and Schumpeterian banking in antebellum New York. *Explorations in Economic History 36*(3), 278–302.

Bodenhorn, H. (2000). *A History of Banking in Antebellum America: Markets and Economic Development in an Era of Nation-Building*. Cambridge University Press.

Bodenhorn, H. (2006). Bank chartering and political corruption in antebellum New York: Free banking as reform. In E. L. Glaeser and C. Goldin (Eds.), *In Corruption and Reform: Lessons from America's Economic History*, pp. 231–257. University of Chicago Press.

Brown, J. R., S. M. Fazzari, and B. C. Petersen (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *Journal of Finance 64*(1), 151–185.

Calomiris, C. and J. Pritchett (2016). Betting on secession: Quantifying political events surrounding slavery and the Civil War. *American Economic Review 106*(1), 1–23.

Calomiris, C. and L. Schweikart (1991). The Panic of 1857: Origins, transmission, and containment. *Journal of Economic History 51*(04), 807–834.

Cameron, A. C., J. B. Gelbach, and D. L. Miller (2008). Bootstrap-based improvements for inference with clustered errors. *Review of Economics and Statistics 90*(3), 414–427.

Card, D. (2001). Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. *Journal of Labor Economics 19*(1), 22–64.

Carlson, M., S. Correia, and S. Luck (2020). The effects of banking competition on growth and financial stability: Evidence from the National Banking Era. Working Paper.

Chava, S., A. Oettl, A. Subramanian, and K. V. Subramanian (2013). Banking deregulation and innovation. *Journal of Financial Economics 109*(3), 759–774.

Chemmanur, T. J., E. Loutskina, and X. Tian (2014). Corporate venture capital, value creation, and innovation. *Review of Financial Studies 27*(8), 2434–2473.

Collins, W. (1904). *The Domestic Slave Trade of the Southern States*. New York: Broadway Publishing Company.

Congress (1832). *United States Congressional Register*, Volume 3137–3140. U.S. Government Printing Office.

Congress (1837). *United States Congressional Serial Set*. Number v. 302. U.S. Government Printing Office.

Conrad, A. H. and J. R. Meyer (1958). The economics of slavery in the ante bellum South. *Journal of Political Economy 66*(2), 95–130.

Cornaggia, J., Y. Mao, X. Tian, and B. Wolfe (2015). Does banking competition affect innovation? *Journal of Financial Economics 115*(1), 95–130.

D'Acunto, F. (2018). From financial history to history & finance. Working Paper.

D'Acunto, F., M. Prokopczuk, and M. Weber (2018). Historical antisemitism, ethnic specialization, and financial development. *Review of Economic Studies 86*(3), 1170–1206.

David, P. A. (1975). *Technical Choice, Innovation and Economic Growth: Essays on American and British Experience in the Nineteenth Century*. Cambridge University Press.

Dong, M., D. A. Hirshleifer, and S. H. Teoh (2021). Stock market overvaluation, moon shots, and corporate innovation. *Journal of Financial and Quantitative Analysis,* forthcoming.

Economopoulous, A. and H. O'Neill (1995). Bank entry during the antebellum period. *Journal of Money, Credit and Banking 27*(4), 1071–1085.

Fleisig, H. (1976). Slavery, the supply of agricultural labor, and the industrialization of the South. *Journal of Economic History 36*(3), 572–597.

Fogel, R. W. and S. L. Engerman (1974). *Time on the Cross: The Economics of American Negro Slavery*. Little, Brown and Company.

Fogel, R. W. and S. L. Engerman (1976a). *Slave Hires, 1775–1865*. Inter-university Consortium for Political and Social Research.

Fogel, R. W. and S. L. Engerman (1976b). *Slave Sales and Appraisals, 1775–1865*. Inter-university Consortium for Political and Social Research.

Goldin, C. and L. F. Katz (1998). The origins of technology-skill complementarity. *Quarterly Journal of Economics 113*(3), 693–732.

Goldin, C. and K. L. Sokoloff (1982). Women, children, and industrialization in the early republic: Evidence from the manufacturing censuses. *Journal of Economic History 42*(4), 741–774.

Goldin, C. and K. L. Sokoloff (1984). The relative productivity hypothesis of industrialization: The American case, 1820 to 1850. *Quarterly Journal of Economics 99*(3), 461–487.

Griliches, Z. (1990). Patent statistics as economic indicators: A survey. *Journal of Economic Literature 28*(4), 1661–1707.

Habakkuk, H. (1962). *American and British Technology in the Nineteenth Century: The Search for Labour Saving Inventions*. Cambridge University Press.

Hall, B. H., A. B. Jaffe, and M. Trajtenberg (2001). The NBER patent citations data file: Lessons, insights, and methodological tools. NBER Working Paper 6508.

Hall, B. H. and J. Lerner (2010). The financing of R&D and innovation. In B. Hall and N. Rosenberg (Eds.), *Handbook of the Economics of Innovation*, Volume 1, pp. 609–639. North Holland.

Hammond, B. (1957). *Banks and Politics in America: From the Revolution to the Civil War*. Princeton University Press.

Hays, J. N. (2005). *Epidemics and pandemics: their impacts on human history*. ABC-CLIO.

Heider, F. and A. Ljungqvist (2015). As certain as debt and taxes: Estimating the tax sensitivity of leverage from state tax changes. *Journal of Financial Economics 118*(3), 684–712.

Higgs, R. (1971). American inventiveness, 1870–1920. *Journal of Political Economy 79*(3), 661–667.

Hilt, E. (2017). Corporation law and the shift toward open access in the antebellum United States. In *Organizations, Civil Society, and the Roots of Development*, pp. 147–177. NBER, Inc.

Holmes, G. K. (1892). Usury in law, in practice and in psychology. *Political Science Quarterly 7*(3), 431–467.

Hombert, J. and A. Matray (2016). The real effects of lending relationships on innovative firms and inventor mobility. *Review of Financial Studies 30*(7), 2413–2445.

Hornbeck, R. and S. Naidu (2014). When the levee breaks: Black migration and economic development in the American South. *American Economic Review 104*(3), 963–990.

Howell, S. T. (2017). Financing innovation: Evidence from R&D grants. *American Economic Review 107*(4), 1136–1164.

Hsu, P.-H., X. Tian, and Y. Xu (2014). Financial development and innovation: Cross-country evidence. *Journal of Financial Economics 112*(1), 116–135.

Huang, R. R. (2008). Evaluating the real effect of bank branching deregulation: Comparing contiguous counties across US state borders. *Journal of Financial Economics 87*(3), 678–705.

International Labour Organization (2017). Global estimates of modern slavery: Forced labour and forced marriage.

Jaremski, M. and P. Rousseau (2013). Banks, free banks, and U.S. economic growth. *Economic Inquiry 51*(2), 1603–1621.

Jayaratne, J. and P. E. Strahan (1996). The finance-growth nexus: Evidence from bank branch deregulation. *Quarterly Journal of Economics 111*(3), 639–670.

Kerr, W. R. and R. Nanda (2009). Democratizing entry: Banking deregulations, financing constraints, and entrepreneurship. *Journal of Financial Economics 94*(1), 124–149.

Kerr, W. R. and R. Nanda (2015). Financing innovation. *Annual Review of Financial Economics 7*(1), 445–462.

King, R. G. and R. Levine (1993a). Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics 108*(3), 717–737.

King, R. G. and R. Levine (1993b). Finance, entrepreneurship and growth. *Journal of Monetary Economics 32*(3), 513–542.

Koudijs, P. and L. Salisbury (2020). Limited liability and investment: Evidence from changes in marital property laws in the US South, 1840–1850. *Journal of Financial Economics 138*(1), 1–26.

Krishnan, K., D. Nandy, and M. Puri (2014). Does financing spur small business productivity? Evidence from a natural experiment. *Review of Financial Studies 28*(6), 1768–1809.

Lamoreaux, N. R. (1996). *Insider Lending: Banks, Personal Connections, and Economic Development in Industrial New England*. Cambridge University Press.

Lamoreaux, N. R. and K. L. Sokoloff (1996). Long-term change in the organization of inventive activity. *Proceedings of the National Academy of Sciences of the United States of America 93*(23), 12686–12692.

Laxton, E. (1997). *The Famine Ships: The Irish Exodus to America, 1846–51*. Bloomsbury.

Lebergott, S. (1960). Wage Trends, 1800–1900. In *Trends in the American Economy in the Nineteenth Century*, pp. 449–500. Princeton University Press.

Levine, R. (1997). Financial development and economic growth: Views and agenda. *Journal of Economic Literature 35*(2), 688–726.

Levine, R., C. Lin, and W. Xie (2020). The African slave trade and modern household finance. *Economic Journal 130*(630), 1817–1841.

Manson, S., J. Schroeder, D. Van Riper, T. Kugler, and S. Ruggles (2020). *IPUMS National Historical Geographic Information System: Version 15.0*. Minneapolis, MN: IPUMS.

Margo, R. A. and G. C. Villaflor (1987). The growth of wages in antebellum America: New evidence. *Journal of Economic History 47*(4), 873–895.

Martin, B. (2010). Slavery's invisible engine: Mortgaging human property. *Journal of Southern History 76*(4), 817–866.

McKinnon, R. (1973). *Money and Capital in Economic Development*. Brookings Institution.

Moser, P. (2012). Innovation without patents: Evidence from world's fairs. *Journal of Law and Economics 55*(1), 43–74.

Murphy, S. A. (2017a). Banking on slavery in the antebellum South. Yale University Economic History Workshop Working Paper.

Murphy, S. A. (2017b). Free banking in Louisiana. Tobin Project Conference on Democracy Working Paper.

Murphy, S. A. (2017c). *Other People's Money: How Banking Worked in the Early American Republic*. How Things Worked. Johns Hopkins University Press.

Nanda, R. and T. Nicholas (2014). Did bank distress stifle innovation during the Great Depression? *Journal of Financial Economics 114*(2), 273–292.

Nunn, N. (2008). The long term effects of Africa's slave trades. *Quarterly Journal of Economics 123*(1), 139–176.

OCC (1876). *Annual Report of the Comptroller of the Currency*. Washington Government Printing Office.

Officer, L. H. and S. H. Williamson (2018). The annual consumer price index for the United States, 1774–present. *Measuring Worth*.

Olmstead, A. L. and P. Rhode (2008). Biological innovation and productivity growth in the antebellum cotton economy. *Journal of Economic History 68*(4), 1123–1171.

Pierce, L. and J. A. Snyder (2017). The historical slave trade and firm access to finance in Africa. *Review of Financial Studies 31*(1), 142–174.

Ransom, R. and R. Sutch (2001). *One Kind of Freedom: The Economic Consequences of Emancipation*. Cambridge University Press.

Rasmussen, W. D. (1982). The mechanization of agriculture. *Scientific American 247*(3), 76–89.

Rockoff, H. (1974). The free banking era: A reexamination. *Journal of Money, Credit and Banking 6*(2), 141–167.

Rolnick, A. J. and W. E. Weber (1983). New evidence on the free banking era. *American Economic Review 73*(5), 1080–1091.

Rosenberg, C. E. (2009). *The Cholera Years: The United States in 1832, 1849, and 1866*. University of Chicago Press.

Rosenberg, N. (1969). The direction of technological change: Inducement mechanisms and focusing devices. *Economic Development and Cultural Change 18*(1), 1–24.

Rosenbloom, J. L. (2018). Antebellum labor markets. In *Oxford Research Encyclopedia of American History*. Oxford University Press.

Schumpeter, J. A. (1934). *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Harvard University Press.

Sokoloff, K. L. (1992). Invention, innovation, and manufacturing productivity growth in the antebellum Northeast. In R. Gallman and J. Wallis (Eds.), *American Economic Growth and Standards of Living before the Civil War*, pp. 345–384. University of Chicago Press.

Temin, P. (1971). Labor scarcity in America. *Journal of Interdisciplinary History 1*(2), 251–264.

Weber, W. E. (2006). Early state banks in the United States: How many were there and when did they exist? *Journal of Economic History 66*(2), 433–455.

Weber, W. E. (2008). Balance sheets for U.S. antebellum state banks. Minneapolis Fed Working Paper.

Willcox, W. F. (1929). *International Migrations, Volume I: Statistics*. National Bureau of Economic Research, New York.

Wittke, C. F. (1939). *We who built America: the saga of the immigrant*. Press of Western Reserve University, Cleveland.

Wright, G. (2006). *Slavery and American Economic Development*. Walter Lynwood Fleming Lectures in Southern History. Louisiana State University Press.

Table 1. Passage of free banking laws

This table lists the passage year of the free banking law for the 18 states. Michigan passed the free banking law in 1837, abolished it in 1840, and reinstated it in 1857. The passage years are from Rockoff (1974).

State	Year of passage	State	Year of passage
Michigan	1837, 1857	Connecticut	1852
New York	1838	Indiana	1852
Georgia	1838	Wisconsin	1852
Alabama	1849	Tennessee	1852
New Jersey	1850	Louisiana	1853
Vermont	1851	Florida	1853
Ohio	1851	Minnesota	1858
Massachusetts	1851	Iowa	1858
Illinois	1851	Pennsylvania	1860

Table 2. Summary statistics

This table reports the summary statistics for the state-year observations of our main sample. For bank variables, we report the summary statistics for the whole sample period, as well as for the state-year observations conditional on passing the free banking law. The definitions of all variables are provided in Appendix A.

	Observations	Mean	Standard deviation	25th percentile	50th percentile	75th percentile
Patents	1,449	25.48	75.23	1	5	19
Agricultural patents	1,449	1.827	6.179	0	0	1
Population (thousands)	1,449	567.1	579.1	158.4	409.7	738.0
Urban ratio	1,449	0.127	0.185	0.019	0.057	0.159
White ratio	1,449	0.818	0.189	0.648	0.919	0.988
Labor exploitation	1,449	0.148	0.171	0.001	0.044	0.304
Bank variables for the whole sample period						
Free bank counts	1,449	3.658	23.29	0	0	0
Free bank assets (thousands)	1,449	2,070	18,112	0	0	0
Free bank loans (thousands)	1,449	1,472	14,182	0	0	0
Charter bank counts	1,449	17.16	25.53	2	6	23
Charter bank assets (thousands)	1,449	13,105	19,083	1,758	6,073	16,197
Charter bank loans (thousands)	1,449	8,909	13,990	1,092	3,709	11,271
Bank variables conditional on passing the free banking law						
Free bank counts	175	30.28	60.86	0	6	25
Free bank assets (thousands)	175	17,140	49,699	0	2,364	8,130
Free bank loans (thousands)	175	12,190	39,274	0	524.3	2,954
Charter bank counts	175	34.06	41.34	4	20	48
Charter bank assets (thousands)	175	28,496	32,557	7,411	17,682	35,710
Charter bank loans (thousands)	175	18,839	25,715	1,501	8,716	18,998

Table 3. Free banking law and access to finance

This table summarizes evidence that the adoption of free banking led to better access to finance. Panel A reports the status of free banks as of three years following the adoption of free banking law for the 18 states. The amounts of bank assets and loans are in thousands. The percentages represent a comparison of levels three years after with levels three years prior to the law's passage. When the value prior to passage was zero, the percentage is denoted as "na." Panel B reports, for both free banks and charter banks, the OLS regression estimates for the response of access-to-finance measures to free banking. Dependent variables in columns (1), (3), and (5) are the natural logarithm of one plus bank counts, assets, and loans of free banks in a state in a given year, respectively. Dependent variables in columns (2), (4), and (6) are the natural logarithm of one plus bank counts, assets, and loans of charter banks in a state in a given year, respectively. The dependent variables lead the independent variables by one year. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

Panel A: Status of free banks as of three years following the passage of the free banking law

	Bank counts		*Assets*		*Loans*	
	Amount	Percentage	Amount	Percentage	Amount	Percentage
Michigan	40	333%	3,448	59%	1,904	57%
New York	74	75%	26,286	21%	21,367	26%
Georgia	1	5%	145	0%	95	1%
Alabama	1	100%	536	10%	313	25%
New Jersey	22	85%	5,945	65%	3,784	58%
Vermont	1	4%	222	4%	152	3%
Ohio	13	22%	3,505	12%	1,463	8%
Massachusetts	0	0%	0	0%	0	0%
Illinois	32	na	7,655	na	1,794	na
Connecticut	14	27%	6,827	27%	5,315	26%
Indiana	83	638%	19,813	259%	7,950	397%
Wisconsin	32	3200%	6,612	875%	3,689	1221%
Tennessee	16	320%	8,130	47%	3,398	29%
Louisiana	4	67%	11,688	30%	763	7%
Florida	0	na	0	na	0	na
Minnesota	16	na	1,197	na	417	na
Iowa	0	na	0	na	0	na
Pennsylvania	0	0%	0	0%	0	0%

Panel B: Free banking and the access to free banks and charter banks

	Ln(1+*Bank counts*)		Ln(1+*Assets*)		Ln(1+*Loans*)	
	Free	Charter	Free	Charter	Free	Charter
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking	1.863***	0.126	10.173***	0.575	9.658***	0.048
	(0.461)	(0.128)	(1.596)	(0.657)	(1.529)	(0.777)
Ln(*Population*)	0.149	-0.103	0.348	1.216*	0.261	0.809
	(0.114)	(0.129)	(0.409)	(0.707)	(0.357)	(0.784)
Urban ratio	2.537	0.063	4.553	2.053	6.145	3.369
	(2.551)	(1.453)	(9.333)	(4.945)	(8.875)	(4.976)
White ratio	0.547	0.154	0.671	12.055	-2.222	10.708
	(1.679)	(2.605)	(7.746)	(12.214)	(5.998)	(12.064)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,410	1,410	1,410	1,410	1,410	1,410
R-squared	0.673	0.900	0.700	0.741	0.706	0.751

Table 4. Free banking and innovation: baseline results

This table reports the OLS regression estimates of equation (1). The dependent variables in columns (1)–(2), (3)–(4), and (5)–(6) are the natural logarithm of one plus the total number of patents granted in a state in year t+1, t+2, and t+3, respectively. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents*)					
	t+1		t+2		t+3	
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking	0.471***	0.403***	0.550***	0.468***	0.570***	0.476***
	(0.165)	(0.120)	(0.180)	(0.127)	(0.199)	(0.138)
Ln(*Population*)		0.453***		0.517***		0.583***
		(0.093)		(0.095)		(0.099)
Urban ratio		1.536*		2.373**		3.069***
		(0.871)		(0.941)		(1.056)
White ratio		1.648		1.931		2.631
		(2.106)		(2.129)		(2.183)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449	1,449	1,449	1,449	1,449	1,449
R-squared	0.877	0.892	0.866	0.887	0.856	0.882

Table 5. Free banking and innovation: county-level identification

This table reports the regression estimates on the relation between access to free banks and future innovation outcomes at the county level. The dependent variable for all columns is the natural logarithm of one plus the total number of patents granted in a county in year t+3. Columns (1)–(3) report OLS regression results using the full county-year sample. Columns (4)–(6) report the results when we restrict to the sample of contiguous border counties. Robust standard errors clustered at the county level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents*)					
	Full county-year sample			Contiguous border counties		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(1+*Free bank counts*)	0.361***			0.280***		
	(0.030)			(0.052)		
Ln(1+*Free bank assets*)		0.028***			0.023***	
		(0.003)			(0.005)	
Ln(1+*Free bank loans*)			0.030***			0.025***
			(0.003)			(0.005)
Ln(*Population*)	0.075***	0.075***	0.078***	0.029	0.025	0.028
	(0.014)	(0.015)	(0.015)	(0.029)	(0.028)	(0.028)
Urban ratio	1.867***	1.888***	1.894***	2.151***	2.162***	2.166***
	(0.236)	(0.238)	(0.238)	(0.297)	(0.297)	(0.297)
White ratio	0.711***	0.747***	0.752***	0.944***	0.950***	0.952***
	(0.110)	(0.115)	(0.116)	(0.212)	(0.213)	(0.213)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State border FE	No	No	No	Yes	Yes	Yes
Observations	51,585	51,585	51,585	16,526	16,526	16,526
R-squared	0.655	0.652	0.651	0.676	0.675	0.675

Table 6. Free banking and agricultural innovation: the role of exploitative labor practices

This table examines the impact of free banking on agricultural innovation across states (counties) with different levels of labor exploitation. *Labor exploitation* is the fraction of a state's (county's) population that was enslaved at the beginning of the antebellum era. Columns (1)–(3) report state-level regression results estimating equation (2); the dependent variable is the natural logarithm of one plus the total number of agricultural patents granted in a state in year t+1, t+2, and t+3, respectively. Columns (4)–(6) report county-level regression results when the dummy variable *Free banking* is replaced with county-level Ln(1+*Free bank counts*); the dependent variable is the natural logarithm of one plus the total number of agricultural patents granted in a county in year t+1, t+2, and t+3, respectively. For the state-level analysis, robust standard errors clustered at the state level are reported in parentheses below each point estimate; for the county-level analysis, robust standard errors clustered at the county level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Agricultural patents*)					
	State-level regressions			County-level regressions		
	t+1	t+2	t+3	t+1	t+2	t+3
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking × *Labor exploitation*	-3.088***	-3.281***	-3.480***			
	(0.586)	(0.586)	(0.579)			
Free banking	0.860***	0.952***	1.024***			
	(0.189)	(0.185)	(0.190)			
Ln(1+*Free bank counts*) ×				-0.461***	-0.466**	-0.514**
Labor exploitation				(0.159)	(0.185)	(0.200)
Ln(1+*Free bank counts*)				0.154***	0.168***	0.182***
				(0.023)	(0.024)	(0.025)
Ln(*Population*)	0.044	0.079	0.120	0.003	0.007	0.013**
	(0.071)	(0.075)	(0.077)	(0.005)	(0.005)	(0.005)
Urban ratio	1.734	2.020*	2.172*	0.409***	0.418***	0.420***
	(1.223)	(1.166)	(1.133)	(0.067)	(0.070)	(0.073)
White ratio	2.862**	2.842**	3.045**	0.188***	0.192***	0.204***
	(1.244)	(1.218)	(1.294)	(0.036)	(0.038)	(0.040)
State FE	Yes	Yes	Yes	No	No	No
County FE	No	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449	1,449	1,449	51,585	51,585	51,585
R-squared	0.712	0.723	0.733	0.274	0.286	0.300

Table 7. The role of exploitative labor practices: robustness results

This table presents robustness checks for the results in Table 6. In panel A, we include additional state-level characteristics—*Agricultural output ratio*, *Education*, *Foreign-born ratio*, *Innovation growth*, *Railway*—and these variables interacted with the dummy variable *Free banking* to the estimation of equation (2). The dependent variable for all columns is the natural logarithm of one plus the total number of agricultural patents granted in year t+3. We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 6. In panel B, we estimate equation (2) using subsamples of relatively similar states and counties. The dependent variable for all columns is the natural logarithm of one plus the total number of agricultural patents granted in year t+3. Column (1) restricts the sample to the states with *Labor exploitation* > 0. Column (2) excludes states in the Northeast. Column (3) restricts the sample to the states with positive cotton output. Columns (4)–(6) repeat the regressions in columns (1)–(3) using county-level observations and by replacing the dummy variable *Free banking* with Ln(1+*Free bank counts*). We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 6. For the state-level analysis, robust standard errors clustered at the state level are reported in parentheses below each point estimate; for the county-level analysis, robust standard errors clustered at the county level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

Panel A: Additional controls	Ln(1+*Agricultural patents*)					
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking × *Labor exploitation*	-3.482***	-2.602***	-2.480***	-3.477***	-2.982***	-3.255***
	(0.663)	(0.390)	(0.617)	(0.578)	(0.603)	(0.917)
Free banking × *Agricultural output ratio*	1.060					1.037
	(0.931)					(1.313)
Agricultural output ratio	0.796					2.151
	(1.232)					(1.360)
Free banking × *Education*		-36.137**				11.419
		(14.485)				(22.117)
Education		9.526				18.818
		(6.303)				(16.468)
Free banking × *Foreign-born ratio*			0.654			0.645
			(0.983)			(1.481)
Foreign-born ratio			4.508			3.953
			(3.690)			(5.817)
Free banking × *Innovation growth*				-0.039		-0.024
				(0.099)		(0.116)
Innovation growth				0.018		-0.088
				(0.016)		(0.070)
Free banking × *Railway*					-0.390	0.024
					(0.515)	(0.802)
Railway					1.118	0.864
					(0.777)	(0.787)
Free banking	0.376	1.280***	0.822**	1.029***	1.102***	0.043
	(0.561)	(0.243)	(0.313)	(0.189)	(0.254)	(1.256)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	399	699	399	1,445	389	386
R-squared	0.864	0.820	0.863	0.734	0.867	0.871

Panel B: Subsample analyses	Ln(1+*Agricultural patents*)					
	State-level regressions			County-level regressions		
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking × *Labor exploitation*	-3.576***	-3.727***	-4.566***			
	(0.637)	(0.601)	(0.846)			
Free banking	1.072***	1.252***	1.618***			
	(0.230)	(0.228)	(0.350)			
Ln(1+*Free bank counts*) × *Labor exploitation*				-0.562***	-0.533***	-0.461***
				(0.191)	(0.094)	(0.088)
Ln(1+*Free bank counts*)				0.218***	0.143***	0.130***
				(0.034)	(0.029)	(0.030)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	No	No	No
County FE	No	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,159	861	784	37,608	41,522	36,317
R-squared	0.738	0.733	0.684	0.307	0.238	0.223

Table 8. Free banking and the marginal cost of labor: the role of exploitative labor practices

This table examines the impact of free banking on local marginal cost of labor across states with different levels of labor exploitation. The dependent variable is *Common laborer wage* in column (1), *Weighted laborer cost* in column (2), *Artisan wage* in column (3), *Weighted artisan cost* in column (4), and *Slave sale value* in column (5). All dependent variables are deflated into real values using the CPI with 1860 as the base year, and lead the independent variables by one year. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Common laborer wage	*Weighted laborer cost*	*Artisan wage*	*Weighted artisan cost*	*Slave sale value*
	(1)	(2)	(3)	(4)	(5)
Free banking ×	-0.169***	-0.249**	-0.211**	-0.443*	0.302**
Labor exploitation	(0.059)	(0.121)	(0.083)	(0.223)	(0.099)
Free banking	0.045***	0.056**	0.029	0.053	-0.128**
	(0.016)	(0.023)	(0.026)	(0.041)	(0.049)
Ln(*Population*)	0.025*	0.017	0.048**	0.020	0.036
	(0.012)	(0.023)	(0.018)	(0.033)	(0.022)
Urban ratio	0.673***	1.099***	0.016	0.999*	-0.048
	(0.166)	(0.336)	(0.108)	(0.521)	(0.269)
White ratio	-0.253	-0.105	-0.504*	-0.409	-0.201
	(0.290)	(0.696)	(0.253)	(1.274)	(0.369)
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	1,023	1,023	1,036	1,036	311
R-squared	0.853	0.834	0.838	0.793	0.883

Table 9. Free banking, the spread of enslavement, and the concentration of slaveholding

This table examines the impact of free banking on exploitative labor practices reflected in the spread of enslavement and the concentration of slaveholding. We restrict our sample to the observations for which data on the distribution of slaveholding are available from the decennial census. The dependent variable in column (1) is *Fraction enslaved*, i.e., the fraction of a state's population that was enslaved in that year. The dependent variable in column (2) is *Percentage of slaveholders*, i.e., the number of slaveholders divided by the white population. The dependent variable in column (3) is *Gini coefficient*, which is calculated based on the distribution of slaveholding among slaveholders. The dependent variables in columns (4)–(7) are, respectively, the percentages of slaveholders with 100 or more, with 50 or more, with fewer than ten, and with fewer than five, enslaved workers. Since the data on the distribution of slaveholding are only available in the 1850 and 1860 census, we present results with and without interpolating the sample in Panel A and Panel B. The number of observations in column (1) is larger than the other columns because the 1850 census provides data for Utah on the enslaved population but not on slaveholding. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Fraction enslaved	*Percentage of slaveholders*	*Gini coefficient*	Distribution of slaveholding among slaveholders			
				100+	50+	1–9	1–4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Interpolated sample: 1850 to 1860							
Free banking	0.162***	0.016***	0.059***	0.005***	0.018***	-0.094***	-0.106***
	(0.027)	(0.004)	(0.011)	(0.001)	(0.003)	(0.017)	(0.022)
Observations	187	177	177	177	177	177	177
R-squared	0.162	0.103	0.150	0.108	0.140	0.149	0.115
Panel B: Only the years 1850 and 1860							
Free banking	0.164**	0.017	0.055*	0.005*	0.019**	-0.109**	-0.123**
	(0.071)	(0.010)	(0.028)	(0.003)	(0.009)	(0.044)	(0.059)
Observations	34	33	33	33	33	33	33
R-squared	0.143	0.083	0.113	0.105	0.142	0.165	0.122

Table 10. Shock to labor exploitation: the 1850s cholera pandemic

This table provides causal evidence on the effect of labor practices on the marginal impact of free banking on innovation by exploiting a plausibly exogenous shock to the supply of exploited workers caused by the 1850s cholera pandemic. The dependent variable is the natural logarithm of one plus the total number of agricultural patents granted in a county in year t+3. In column (1), *Enslaved cholera deaths* equals the fraction of a county's enslaved population that died of cholera in 1850 for the years 1850–1854, and zero for the years 1855–1860. In column (2), *Enslaved cholera deaths* equals the fraction of a county's enslaved population that died of cholera in 1850 for the years 1850–1855, and zero for the years 1856–1860. In column (3), *Enslaved cholera deaths* equals the fraction of a county's total enslaved deaths that were caused by cholera in 1850 for the years 1850–1854, and zero for the years 1855–1860. In column (4), *Enslaved cholera deaths* equals the fraction of a county's enslaved population that died in 1850 from one of the eight major deadly and contagious diseases (including cholera) for the years 1850–1854, and zero for the years 1855–1860. We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 6. The sample consists of 722 unique counties in the period 1850–1860. Robust standard errors clustered at the county level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Agricultural patents*)			
	(1)	(2)	(3)	(4)
Ln(1+*Free bank counts*) × *Enslaved cholera deaths*	0.703***	0.425***	0.245***	0.728***
	(0.138)	(0.071)	(0.038)	(0.179)
Enslaved cholera deaths	-0.105	0.012	-0.056	-0.137
	(0.163)	(0.093)	(0.046)	(0.211)
Ln(1+*Free bank counts*)	-0.002	-0.001	-0.007	-0.003
	(0.023)	(0.023)	(0.024)	(0.024)
Controls	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	7,942	7,942	7,942	7,942
R-squared	0.251	0.247	0.251	0.251

Table 11. Shock to labor exploitation: the influx of Irish immigrants

This table provides causal evidence on the effect of labor practices on the marginal impact of free banking on innovation by exploiting a plausibly exogenous shock to the supply of exploited workers caused by the influx of Irish immigrants. The dependent variable is the natural logarithm of one plus the total number of patents granted in year t+1, t+2, and t+3, respectively. *Irish immigrants* is the estimated total number (in thousands) of Irish immigrants that arrived in a state in a given year. This variable is available from 1820 to 1860 and is constructed using the annual aggregate inflow of Irish immigrants into the US based on the shift-share instrument approach. We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 6. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents*)					
	t+1	t+2	t+3	t+1	t+2	t+3
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking × *Irish immigrants*	-0.024***	-0.023***	-0.022***			
	(0.008)	(0.008)	(0.008)			
Free banking	0.429***	0.505***	0.514***			
	(0.137)	(0.140)	(0.151)			
Ln(1+*Free bank counts*) × *Irish immigrants*				-0.007***	-0.006***	-0.006***
				(0.002)	(0.002)	(0.002)
Ln(1+*Free bank counts*)				0.171**	0.179***	0.184**
				(0.064)	(0.064)	(0.068)
Irish immigrants	0.022***	0.017**	0.015**	0.024***	0.019**	0.015**
	(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,246	1,246	1,246	1,246	1,246	1,246
R-squared	0.900	0.894	0.890	0.901	0.894	0.889

Appendix: For Online Publication

Description of online appendices

- Online Appendix I: A Brief Legislative History
- Online Appendix II: Additional Tables
- Online Appendix III: Historical Documents

Online Appendix I: A Legislative History of Free Banking Laws

One concern about our identification strategy, which uses the staggered passage of free banking laws across states as a shock, is that the timing might be anticipated by the agents in our analysis or in response to market trends. Anticipation could lead to delayed or accelerated actions by inventors and manufacturers, confounding the assumption of parallel trends. This section addresses this concern by describing the events leading up to the law's passage.

Records documenting the legislative history of early banking are rare. We reference the Annual Report of the Comptroller of the Currency (1876) and Sumner (1896) as well as other historical studies (e.g., Bodenhorn, 2006; Du, 2010; Murphy, 2017; Gandhi, 2003) to provide background on those states where records are available. Evidence shows that laws passed in different states often reflected contradictory political impulses, suggesting that the passage of free banking laws was plausibly exogenous.

New York (1838) Economic historians consider the law's passage in New York in 1838 to have been a serendipitous event. It made its way against a great deal of opposition. The elimination of special charters and their replacement with general incorporation procedures was not a sudden post-1835 revelation for the proponents of free banking (Bodenhorn, 2006). In 1825 the New York Senate considered a bill that would have repealed the restraining acts that forbade private banking in the state—a first step toward free banking (New York State Senate, 1825). The original 1829 bill that established New York's Safety Fund system included a provision that would have liberalized entry, though the provision was removed from the bill's final version (Hammond, 2006).

While several political leaders, e.g., political columnist William Leggett, Richard Hildreth, and William Marcy, had advocated the abandonment of special charters in the 1830s, the law's passage in 1838 was triggered by an unlikely event, the kidnapping of a man named William Morgan after he threatened to

reveal the secrets of Freemasonry. Within a year of Morgan's disappearance, Freemasonry's critics called a series of conventions and formed a political movement. The Antimasonic Party was born and, although its central philosophy remained anti-freemason, it attracted voters unhappy with the Regency's spoils and patronage. When the Regency lost support, the Whig Party (formed when the Antimasons joined with the National Republicans) gained more power. Governor Marcy ultimately signed the Free Banking Act into law on April 18, 1838, a sequence of events economist Bodenhorn calls the "serendipitous nature of economic reform" (Bodenhorn, 2006, p. 21).

Illinois (1851) The law's passage in Illinois was a long and challenging process, and the specific timing of the Act was somewhat unexpected. In the constitutional convention of 1847, the banking issue became one focus of the delegates' attention. Whigs were considered as speaking on behalf of banks, and Democrats insisted on an anti-bank provision. In the convention, Democrats outnumbered Whigs ninety-one to seventy-one, and Democrats were dominant in political affairs (Cornelius, 1969). As a result, the new constitution still prohibited the establishment of banks. In 1848, a convention was held in Chicago, where representatives of the state's leading commercial and financial interests drafted a memorandum to the legislature and the governor, urging them to abandon their attitude of hostility toward banks and to provide the state with a system of banking to supply some type of convenient and convertible circulating medium. Their appeal was successful, and a general banking law with the purpose of establishing a free banking system was passed by the legislature of 1848, to be submitted to the people at a general election.

The next general election would have taken place in 1852, but the legislature deprived all the county treasurers of their offices and provided that their successors should be elected in 1851 (Du, 2010, p. 6). This exception made it possible to pass the free banking law a year earlier.

Louisiana (1853) Free banking in Louisiana was rooted in the repercussions of the anti-banking philosophy (Murphy, 2017). Beginning in 1804, the state chartered several commercial banks; whereas these banks accommodated the commercial interests of merchants in New Orleans, restrictions on their lending practices meant that they failed to meet the needs of the planters who were rich in terms of land and enslaved labor but poor in cash. Thus, beginning in 1828, Louisiana pioneered a new banking system known as plantation banks, which allowed planters to use their vast wealth in land and enslaved workers as security. When this system came crashing down after the Panics of 1837 and 1839, Louisianans turned against all banks, joining in an anti-banking wave initiated by Andrew Jackson and hard-money Democrats. This culminated in the Louisiana Bank Act of 1842, which imposed restrictive measures on banking and the rewriting of the state constitution in 1845, which banned both new banks and the renewal of existing banking charters (Gandhi, 2003). The state economy suffered under this contractionary banking policy. By 1851, public opinion in Louisiana had also shifted back decisively in favor of banking. While the law's passage might be associated with a political economy story in some other states, this was not the case in Louisiana. Both Democrat

and Whig parties alike were scrambling to keep up with these shifts in public opinion, virtually erasing any differences in their political rhetoric with regard to banking.

During the constitutional convention of 1852, however, four of the eleven members of the Committee on General Provisions expressed their discontent with the proposed bill. The convention proceeded to debate and vote on these proposals and, in the end, the convention accepted the original language of the committee report, which would allow banking under both special acts of the legislature and general incorporation. By mid-August, the new constitution was complete; the convention overwhelmingly ratified the final document by a vote of 98-8. The last step was the approval by the voters of the state. However, quite unexpectedly, as the statewide vote on the new document approached, an apportionment clause became the central issue for the opposition. In November of 1852, the voters of Louisiana eventually voted to accept the new constitution, which symbolized the enactment of the free banking law in 1853.

Massachusetts (1851) Antebellum Massachusetts possessed greater banking experience than other states; since a thriving banking system was already in place, the passage of the free banking law in 1851 had relatively little impact on the state.

The Massachusetts Bank of Boston was the earliest chartered bank in Massachusetts. Petitioners for this bank wanted to provide credit, a money supply and convenience for business transactions to the community (Gras, 1937). By the 1820s, motives for the petition for bank charters were more in the interest of a subset of the community, e.g., the mechanics or planters (Lamoreaux, 1996). By the 1830s, obtaining a charter to erect a new bank did not seem to be a prohibitive barrier to entry. Until the 1830s demand for credit was large and the banking sector expanded considerably from 1830 to 1837. The 1837 Panic hit the Massachusetts banks and caused bank suspensions. After banks resumed payments in specie in 1844, the sector expanded steadily. Therefore, when a free banking law was passed in Massachusetts in 1851, a thriving banking system was already in place and had been working for quite some time. The free banking law, known for easing barriers to entry, had little impact on the size of the Massachusetts banking sector as evidenced by the fact that only seven banks were founded under it (Gandhi, 2003).

Several features and bank regulations explain why the Massachusetts banking sector outperformed. A distinctive feature is the existence of a clearinghouse system called the Suffolk System. This system began in 1818 and facilitated note redemption by allowing member banks to share the cost of transporting and redeeming country banknotes. Moreover, in response to the Panic of 1837, in 1838 the state created a Board of Bank Commissioners that annually conducted bank examinations. Lamoreaux (1996) proposes that the 1838 law also marked the beginning of a trend of Massachusetts's lawmakers attempting to protect bank stockholders relative to bank directors.

Ohio (1851) The timing of free banking law's passage in 1851 was somewhat unexpected for Ohio as that was the first year Democrats won the election after a long six-year control of the governorship by the

Whigs. The constitutions adopted after that also made the experience of Ohio unique.

During the 1830s there was a great demand for credit; Ohio banks met this demand with a rapid increase of bank paper. Like other states, Ohio banks suspended payment in the Panic of 1837. The suspensions led to the Bank Commissioner Law in 1839, which restricted the maximum legal ratio of circulating notes to specie reserves and also established a committee to examine the state's banks regularly (Gandhi, 2003). Even though many bank charters were to expire by 1843, the Democrats passed the Latham Banking Act in 1842. This act created a special tax on circulation and capital, and made bankers personally liable for the banks' losses. While this act was not appealing to bankers, the public supported it and a Democrat won the election for governor in 1842 with an anti-bank campaign. The shortage of credit and currency due to bank closings provoked a split within the Democratic party: those legislators allied with bankers passed the Wooster Bank Bill in 1844, which extended the charter of five banks. The cleavage among Democrats allowed Whigs to regain the governorship in 1844 and to pass the Kelley Bank Act of 1845. This act created a state bank and a safety fund system. Many independent banks were organized under this act. The public's perception of the new banking system was positive, and the banking system remained unchanged for six years (Huntington, 1915).

On March 21, 1851, Ohio passed the free banking law despite some opposition. However, a new constitution, adopted in June 1851, contained an article prohibiting the organization of additional banks, without the approval by the people at the next succeeding general election following the law authorizing the same (OCC, 1876). Moreover, the legislature passed a tax law in 1852, which levied upon the banks double, and in some instances triple, the rate imposed upon any other property. Most banks organized under the free banking law were ultimately obliged to go into liquidation because of the oppressive taxation (OCC, 1876).

Tennessee (1852) In Tennessee, a small, primarily state-controlled banking system dominated the state from 1830 until 1852, when the free banking law was passed.

In response to the Panic of 1819 but despite protest, the charter for the State Bank of Tennessee in Nashville was granted in 1820. However, by the end of the decade, anti-bank forces occupied the state congress and ordered the banks to be discontinued. The legislature also passed a law in 1827 that mandated that any firm wishing to carry on banking activities must obtain a charter. Later, this contraction would worsen the pressure on the community, causing popular demand for a new bank. The legislature satiated this demand by chartering the Union Bank in 1832 and the Planters' Bank in 1833. In 1839, the Democrats, who had just regained the governorship, attempted to have the banks surrender their charters. Fortunately for the banks, this never occurred because some Democratic legislators crossed party lines to vote against it. Not only did these banks survive the Panic but also the suspension actually incited the legislature to found another state bank in 1839 (Gandhi, 2003).

Little bank entry occurred during the antebellum period until 1853. In 1852, Tennessee passed a free banking law, authorizing the organization of banks upon a deposit of bonds of the State equal to the amount

of their capital (OCC, 1876). The free banking law was rectified in 1856 with market valuation restriction.

Connecticut (1852) The free banking law was passed in 1852, after a hard two-year struggle. A special stress was laid upon the provision that every bank must be one of discount and deposit, and not simply of circulation. The free banking law, however, was so modified in 1855 as to be in effect repealed, by converting all the free banks into joint-stock banks under a general law. The notes were to be surrendered and the securities taken up. Circulation was limited under the new law to one hundred and fifty percent of the capital. In case of failure, the note-holders "shall have a lien on all the estate of said corporation of every description." By June 26, 1855, all the banks under the free banking law were compelled to accept subscriptions of charitable and educational societies, according to the Connecticut custom (Sumner, 1896).

New Jersey (1850) The Constitution of 1844 required a three-fifths vote in each House for granting or renewing bank charters, which were also to be limited to twenty years' duration. In 1855, the bank circulation was made a preferred debt, for which, according to each charter, all the assets were pledged; also, each stockholder was liable for double his stock, and the directors were individually liable without limit. It was reported that, in 1857, all banks under the free banking law of February 27, 1850, were trying to get special charters. The free bank system had fallen into disfavor in New Jersey and was being abandoned (Sumner, 1896).

Alabama (1849) The tax collectors of Alabama appear to have been speculating on the depreciation of the currency, for an act was passed February 4, 1846, to prevent them from doing so. It was enacted March 4, 1848, that no foreign corporation should do discount banking in Alabama, unless it did so using gold and silver or notes issued under the authority of the State. Notes discounted contrary to this law were to be void. The Southern Bank of Alabama was chartered February 12, 1850. On the same day, a free banking law was adopted. The lowest note was set at $5, which was changed in 1852 to $2. At that time, also, the Southern Bank was authorized to make its circulation thrice its capital. Then, the Northern Bank of Alabama was chartered similarly to the Southern Bank (Sumner, 1896).

Indiana (1852) The State Bank of Indiana was incorporated in 1834. In November 1851, the new constitution prohibited the organization of banks except under a general law (OCC, 1876), which, if passed, must provide for registry of notes by a State officer, with ample security, in the custody of a State officer. On May 28, 1852, the free banking law was passed and provided that United States stocks or stocks of the several States, including those of Indiana, should be deposited with the auditor as security for circulating notes, the stocks to be made equal to one bearing six percent interest. The law did not require a board of directors, nor that the stockholders should be citizens of the State. In October 1854 there were 83 free banks in Indiana (Sumner, 1896).

Wisconsin (1853) In the 1830s and 1840s, few banks were chartered by the Territorial Legislature. An act creating a State Bank of Wisconsin at Prairie du Chien was disallowed on June 12, 1838, but the Wisconsin Marine and Fire Insurance Company of Milwaukee was chartered in 1839. In the Constitution of 1848, the Legislature was forbidden to create any bank in any way, unless the question of bank or no bank should have been decided at a general election in favor of banks. Then it might create banks by general or special law, but every such law must be ratified by a majority at a general election before it should be valid. A free banking law was passed in 1853. The possibilities of mischief in Wisconsin's free banking system were amply manifested (Sumner, 1896).

Iowa (1858) The Miners' Bank of Dubuque, chartered by the Territory of Wisconsin, was the only bank in Iowa in 1840. It suspended in March 1841 and resumed July 1, 1842; its charter was repealed in 1844, by virtue of a power reserved to the Legislature to do so. While a number of Whigs joined with Democrats in various attempts to repeal the bank's charter, the struggle did not have an ultimate political impact. The sorry showing of the Miners' Bank strengthened the hand of the anti-bank wing of the Iowa Democratic Party so that in the Constitutional Convention of 1846 they controlled the party and were able to pass a constitutional prohibition of all banks of issue in Iowa—a prohibition that lasted until 1857 (Erickson, 1969). The free banking law of 1858 forbade the payment of interest on deposits, required a specie reserve of 25 percent of deposits, prescribed that stocks deposited for circulation must pay six percent or more and that the circulation issued should not exceed 90 percent of the value of the bonds (Sumner, 1896).

Online Appendix II: Additional Tables

Table A.1. List of states

This table lists the 39 states in our sample, the year of territory/statehood, their status regarding abolished enslavement or not, the fraction in percentage of a state's population that was enslaved when the state entered the antebellum era (*Labor exploitation*), and the fraction in percentage of a state's population that was enslaved (*Fraction enslaved*) in 1860.

State	Year of territory/statehood	Status of abolishment	*Labor exploitation* (%)	*Fraction enslaved* in 1860 (%)
Alabama	1819	No	32.7	45.1
Arkansas	1819	No	11.3	25.5
California	1850	Yes	0	0
Connecticut	1788	Yes	0.12	0
Delaware	1787	No	5.75	1.60
District of Columbia	1790	No	22.5	4.24
Florida	1822	No	44.6	44.0
Georgia	1788	No	41.7	43.7
Illinois	1809	Yes	1.37	0
Indiana	1800	Yes	0.97	0
Iowa	1838	Yes	0.04	0
Kansas	1854	Yes	0	0
Kentucky	1792	No	19.8	19.5
Louisiana	1804	No	45.3	46.9
Maine	1788	Yes	0	0
Maryland	1788	No	29.3	12.7
Massachusetts	1788	Yes	0	0
Michigan	1805	Yes	0.50	0
Minnesota	1849	Yes	0	0
Mississippi	1798	No	42.3	55.2
Missouri	1812	No	14.4	9.72
Nebraska	1854	Yes	0.05	0.05
New Hampshire	1788	Yes	0	0
New Jersey	1787	Yes	4.42	0
New Mexico	1850	No	0	0
New York	1788	Yes	1.57	0
North Carolina	1789	No	30.4	33.4
Ohio	1803	Yes	0	0
Oregon	1848	Yes	0	0
Pennsylvania	1787	Yes	0.10	0
Rhode Island	1790	Yes	0.14	0
South Carolina	1788	No	47.3	57.2
Tennessee	1796	No	17.0	24.8
Texas	1846	No	27.4	30.2
Utah	1850	No	0.23	0.07
Vermont	1791	Yes	0	0
Virginia	1788	No	40.3	30.7
Washington	1853	Yes	0	0
Wisconsin	1836	Yes	0.04	0

Table A.2. Determinants of the free banking law's passage

This table reports the results from Cox proportional hazards model analyzing the hazard of a state passing the free banking law. A "failure event" is the passage of the free banking law in a state, and states are excluded from the sample once they passed the law. For Michigan, which passed the law twice, we use 1857 as the free banking year for this analysis. The dependent variable is the log of the expected time to the law's passage. *Common laborer wage*, *Agricultural output*, and *Manufacturing output* are deflated to real values using the CPI with 1860 as the base year. All independent variables, except for the dummy variable (*Political party*), are standardized to have a mean of zero and a standard deviation of one. Robust standard errors clustered at the state level are reported in parentheses below each point estimate for the hazard ratio. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Duration model for the time until the law's passage				
	(1)	(2)	(3)	(4)	(5)
Ln(*Population*)	1.382	1.367	1.367	1.606	1.619
	(0.300)	(0.334)	(0.438)	(0.938)	(0.968)
Urban ratio	0.716	0.710	0.710	0.443	0.304
	(0.277)	(0.282)	(0.335)	(0.575)	(0.488)
Labor exploitation	0.592	0.609	0.608	0.402	0.482
	(0.222)	(0.242)	(0.261)	(0.360)	(0.372)
Common laborer wage		0.996	0.996	0.789	0.633
		(0.305)	(0.293)	(0.536)	(0.490)
Innovation growth			1.012	1.052	1.070
			(0.015)	(0.083)	(0.101)
Ln(1+*Bank counts*)			0.998	0.627	0.365
			(0.364)	(0.223)	(0.352)
Political party				1.560	1.410
				(1.079)	(0.950)
Agricultural labor ratio				0.396	0.275
				(0.370)	(0.286)
Agricultural output				0.927	1.095
				(1.074)	(1.118)
Manufacturing output				1.032	0.862
				(1.046)	(0.765)
Education					0.090
					(0.179)
Railway					2.995
					(5.074)
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	1,256	925	925	137	137
Pseudo R-squared	0.082	0.065	0.065	0.101	0.112

Table A.3. Temporal dynamics

This table reports the temporal dynamics of innovation before and after free banking. In column (1), we decompose *Free banking* in equation (1) into four dummy variables associated with four periods around the enactment: all years up to and including one year prior to free banking ($Before^{1-}$), one to two years after free banking ($After^{1\&2}$), three to four years after free banking ($After^{3\&4}$), and five years or more after free banking ($After^{5+}$). For Michigan, which passed the law twice, we use 1857 as the free banking year for this estimation. In column (2), we further decompose $After^{5+}$ into five to six years after free banking ($After^{5\&6}$) and seven years or more after free banking ($After^{7+}$). Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents*)	
	t+1	t+1
	(1)	(2)
$Before^{1-}$	-0.146	-0.146
	(0.141)	(0.141)
$After^{1\&2}$	0.266**	0.265**
	(0.117)	(0.117)
$After^{3\&4}$	0.328**	0.328**
	(0.160)	(0.160)
$After^{5+}$	0.361**	
	(0.157)	
$After^{5\&6}$		0.367**
		(0.164)
$After^{7+}$		0.359**
		(0.167)
Ln(*Population*)	0.461***	0.461***
	(0.091)	(0.091)
Urban ratio	1.488*	1.489*
	(0.844)	(0.842)
White ratio	1.767	1.765
	(2.076)	(2.078)
State FE	Yes	Yes
Year FE	Yes	Yes
Observations	1,449	1,449
R-squared	0.893	0.893

Table A.4. Robustness of the relation between free banking and innovation

This table reports the robustness checks of the baseline results. Columns (1) and (2) report results estimating a Poisson regression model, in which the dependent variable is the total number of patents granted in a state in year t+3. We additionally include state-specific pre-trends in column (2). Columns (3)–(7) report subsample analyses of our baseline OLS regression, in which the dependent variable is the natural logarithm of one plus the total number of patents granted in a state in year t+3. Column (3) includes only the state-year observations with non-zero patents. Column (4) restricts the sample period to 1837–1860. Column (5) restricts the sample period to 1850–1860. Column (6) excludes the "wildcat banking" states, i.e., Michigan, Indiana, Illinois, Wisconsin, Minnesota, and New Jersey, as listed in Rockoff (1974). Column (7) excludes states in the west, i.e., California, Kansas, Nebraska, New Mexico, Oregon, Texas, Utah, and Washington. Columns (8)–(9) control for contemporaneous laws and regulation changes. Column (8) controls for the maximum interest rate limit imposed by the usury laws. Column (9) controls for the general incorporation statutes for manufacturing firms. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Poisson		OLS						
	Baseline	State-specific pre-trends	Non-zero patents	Year>1836	Year>1849	No "wildcat"	No west	Usury law	Incorporation law
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Free banking	0.136**	0.091**	0.263***	0.293**	0.562**	0.359**	0.469***	0.455***	0.539***
	(0.068)	(0.044)	(0.096)	(0.143)	(0.210)	(0.132)	(0.137)	(0.137)	(0.162)
Ln(*Population*)	1.589***	1.648***	0.815***	0.737***	0.581**	0.552***	0.589***	0.735***	0.604***
	(0.197)	(0.213)	(0.124)	(0.188)	(0.272)	(0.144)	(0.100)	(0.122)	(0.098)
Urban ratio	0.427	1.779**	2.759***	5.203***	5.911	2.862***	3.056***	3.333***	2.811**
	(0.505)	(0.695)	(0.975)	(1.574)	(4.645)	(0.998)	(1.056)	(1.077)	(1.059)
White ratio	-2.299	-1.421	0.482	0.593	-0.218	3.062	3.126	3.631	2.905
	(1.702)	(2.034)	(1.863)	(2.838)	(4.846)	(1.852)	(2.251)	(2.198)	(2.127)
Max rate								-0.443	
								(0.561)	
Incorporation law									-0.212
									(0.139)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449	1,449	1,208	783	399	1,221	1,391	1,392	1,449
R-squared			0.893	0.908	0.913	0.891	0.883	0.883	0.884

Table A.5. Little free banking and large free banking

This table reports how free banking affected innovation based on the intensity of free bank entry. Dependent variables are the natural logarithm of one plus the total number of patents granted in a state in year t+1, t+2, and t+3, respectively. Columns (1)–(3) show how *Little free banking* affected innovation, and columns (4)–(6) show how *Large free banking* affected innovation. *Little (Large) free banking* is an indicator variable that takes the value of one if *Free banking* equals one and the state had little (significant) free banking activities, and zero otherwise. Of the 18 states that adopted free banking, seven had only little activity by free banks, and 11 had significant or "large" levels of activity by free banks. We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 4. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents*)					
	t+1	t+2	t+3	t+1	t+2	t+3
	(1)	(2)	(3)	(4)	(5)	(6)
Little free banking	0.078	0.139	0.119			
	(0.149)	(0.169)	(0.200)			
Large free banking				0.488***	0.534***	0.559***
				(0.152)	(0.160)	(0.171)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449	1,449	1,449	1,449	1,449	1,449
R-squared	0.889	0.882	0.878	0.893	0.887	0.883

Table A.6. Free banking and agricultural innovation: contemporaneous measure of labor exploitation

This table presents robustness checks for the results in Table 6. We measure *Labor exploitation* alternatively as the contemporaneous *Fraction enslaved*, i.e., the fraction of a state's (county's) population that was enslaved in a given year. The controls include Ln(*Population*), *Urban ratio*, and *Fraction enslaved*. We do not include *White ratio* in the model because it is highly collinear with the contemporaneous *Fraction enslaved*. For the state-level analysis, robust standard errors clustered at the state level are reported in parentheses below each point estimate; for the county-level analysis, robust standard errors clustered at the county level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

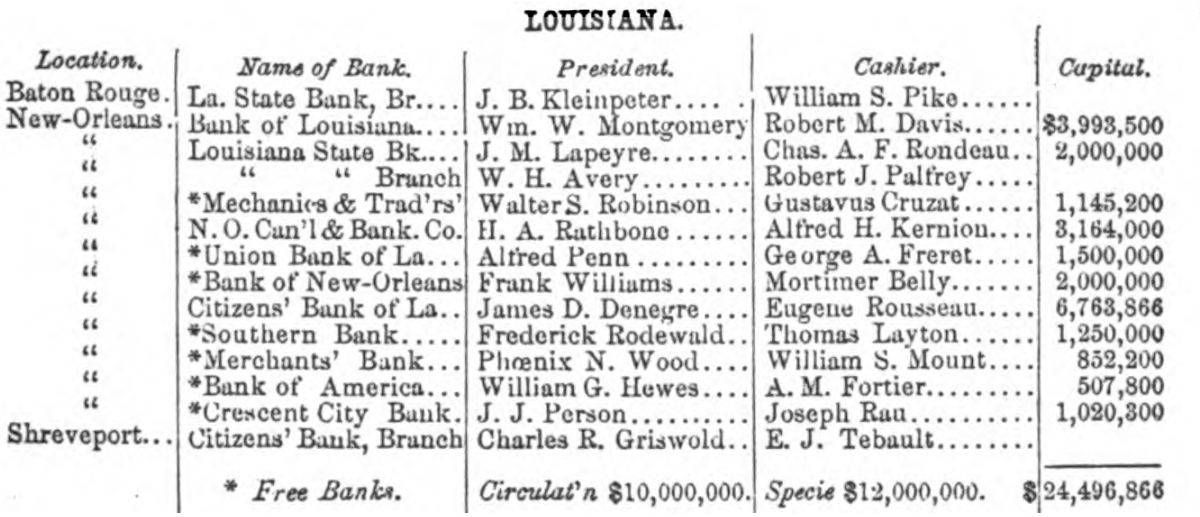
	Ln(1+*Agricultural patents*)					
	State-level regressions			County-level regressions		
	t+1	t+2	t+3	t+1	t+2	t+3
	(1)	(2)	(3)	(4)	(5)	(6)
Free banking × *Fraction enslaved*	-2.729***	-2.914***	-3.080***			
	(0.539)	(0.534)	(0.523)			
Free banking	0.840***	0.934***	1.005***			
	(0.187)	(0.182)	(0.188)			
Ln(1+*Free bank counts*) × *Fraction enslaved*				-0.648***	-0.691***	-0.753***
				(0.106)	(0.112)	(0.115)
Ln(1+*Free bank counts*)				0.151***	0.166***	0.179***
				(0.023)	(0.025)	(0.025)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	No	No	No
County FE	No	No	No	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,449	1,449	1,449	51,585	51,585	51,585
R-squared	0.712	0.724	0.735	0.275	0.286	0.300

Table A.7. Free banking under exploitative labor practices: agricultural vs. non-agricultural patents

This table examines the differential impact of free banking on agricultural patents relative to non-agricultural patents in states with *Labor exploitation* above the sample median. The dependent variables in columns (1)–(3) are the natural logarithm of one plus the total number of agricultural or non-agricultural patents granted in year t+1, t+2, and t+3, respectively. The indicator variable, *Agriculture dummy*, takes the value of one if the dependent variable measures the agricultural patents and zero if it measures the non-agricultural patents. Each state-year observation appears twice in the sample of this test, once when the dependent variable is for agricultural patents and once for non-agricultural patents. We include the same set of controls (Ln(*Population*), *Urban ratio*, and *White ratio*) as in Table 6. Robust standard errors clustered at the state level are reported in parentheses below each point estimate. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. The definitions of all variables are provided in Appendix A.

	Ln(1+*Patents: agricultural or non-agricultural*)		
	t+1	t+2	t+3
	(1)	(2)	(3)
Free banking	0.390**	0.407**	0.375**
	(0.164)	(0.159)	(0.174)
Free banking × *Agricultural dummy*	-0.730**	-0.696**	-0.665**
	(0.271)	(0.259)	(0.273)
Agricultural dummy	-1.093***	-1.108***	-1.127***
	(0.152)	(0.150)	(0.148)
Controls	Yes	Yes	Yes
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	1,440	1,440	1,440
R-squared	0.806	0.806	0.805

Online Appendix III: Historical Documents



LOUISIANA.

Location.	*Name of Bank.*	*President.*	*Cashier.*	*Capital.*
Baton Rouge.	La. State Bank, Br....	J. B. Kleinpeter....	William S. Pike.....	
New-Orleans.	Bank of Louisiana....	Wm. W. Montgomery	Robert M. Davis.....	$3,993,500
"	Louisiana State Bk....	J. M. Lapeyre.....	Chas. A. F. Rondeau..	2,000,000
"	" " Branch	W. H. Avery.....	Robert J. Palfrey.....	
"	*Mechanics & Trad'rs'	Walter S. Robinson...	Gustavus Cruzat.....	1,145,200
"	N. O. Can'l & Bank. Co.	H. A. Rathbone.....	Alfred H. Kernion....	3,164,000
"	*Union Bank of La...	Alfred Penn.....	George A. Freret.....	1,500,000
"	*Bank of New-Orleans	Frank Williams.....	Mortimer Belly.....	2,000,000
"	Citizens' Bank of La..	James D. Denegre....	Eugene Rousseau.....	6,763,866
"	*Southern Bank.....	Frederick Rodewald..	Thomas Layton.....	1,250,000
"	*Merchants' Bank...	Phœnix N. Wood....	William S. Mount....	852,200
"	*Bank of America...	William G. Hewes....	A. M. Fortier.....	507,800
"	*Crescent City Bank.	J. J. Person.....	Joseph Rau.....	1,020,300
Shreveport...	Citizens' Bank, Branch	Charles R. Griswold..	E. J. Tebault.....	
	* *Free Banks.*	*Circulat'n* $10,000,000.	*Specie* $12,000,000.	$24,496,866

Figure A.1. The Merchant's and Banker's Almanac: Louisiana banks. This figure illustrates that seven out of a total of 11 Louisiana banks in 1859 were free banks according to the *Merchant's and Banker's Almanac*, 1860 edition.

TENNESSEE.

Location.	*Name of Bank.*	*President.*	*Cashier.*	*Capital.*
Brownsville..	Agricultural Bank....	R. C. Hamil.....	William McConihe...	$100,000
Chattanooga..	Bank of Chattanooga..	William Williams....	W. D. Fulton.....	212,000
Clarksville..	*Northern Bk.of Tenn.	D. N. Kennedy.....	James L. Glenn.....	50,000
Cleveland....	Ocoee Bank.....	Thomas H. Callaway..	Thomas J. Campbell..	100,000
Dandridge...	*Dandridge Bank.....	John Roper.....	William A. Branner..	500,000
Lebanon.....	*Bank of Middle Tenn.	S. T. Mottley.....	C. W. Jackson	50,000
Tazewell.....	*Bank of Tazewell....	E. H. Skaggs.....	C. Hitchings	100,000
"	*Bank of Clairborne..	R. J. Foster.....	I. L. Evans	50,000
Knoxville....	Bank of East-Tenn....	W. M. Churchwell....	A. A. Barnes.....	500,000
Chattanooga..	" " Branch	.....	W. F. Ragsdale	
Jonesville....	" " "	.....	W. G. Gammon.....	
Nashville....	*Bank of Nashville...	Nicholas Hobson.....	Wesley Wheless.....	500,000
"	*Bank of Commerce..	J. D. James.....	A. Wheless	50,000
"	*Merchants' Bank....	W. B. Shapard, Jr....	J. Porterfield.....	50,000
"	*City Bank	Dyer Pearl.....	E. G. Pearl.....	50,000
"	*Traders' Bank	W. B. Dortch.....	.....	50,000
"	Bk. of Tennessee	Cave Johnson.....	James Morton.....	1,325,916
Athens.....	" " Branch	.....	J. Blizard.....	249,150
Clarksville...	" " "	R. W. Humphreys....	B. H. Wisdom	223,931
Columbia.....	" " "	James Akin.....	J. C. Rye	190,130
Rogersville...	" " "	William Hutchesson..	H. Fain.....	254,208
Shelbyville ..	" " "	Robert Mathews.....	R. N. Wallace,.....	223,931
Somerville...	" " "	H. Owen.....	James Pettit.....	254,208
Sparta.....	" " "	J. G. Mitchell.....	William M. Young....	223,931
Trenton.....	" " "	John S. Davis.....	John A. Taliaferro....	254,208
Memphis	*Commercial Bank ...	Daniel B. Turner.....	W. A. Jones.....	50,000
"	*Bank of Memphis...	R. C. Brinkley	W. F. Barry	50,000
"	Citizens' Bank.....	S. P. Walker.....	.....	50,000
Murfreesboro'	*Exchange Bank	William Spence.....	J. Spence.....	100,000
Knoxville....	*Farmers' Bank.....	W. B. Shepherd, Jr...	William T. Wheless..	50,000
"	Miners & Manuf. Bk..	J. L. King.....	A. L. McClung.....	100,000
"	*Bank of Knoxville...	Dyer Pearl.....	E. G. Pearl	50,000
Nashville....	Planters' Bk. of Tenn.	Orville Ewing.....	D. Weaver.....	1,498,300
Athens.....	" " Branch	James H. Reagan.....	David Cleage.....	150,000
Clarksville...	" " "	H. F. Beaumont.....	William P. Hume	150,000
Franklin.....	" " "	J. H. Otey.....	William S. Campbell..	150,000
Memphis	" " "	J. Elder	James Penn.....	150,000
Pulaski.....	" " "	A. M. Ballentine	G. W. Petway.....	150,000
Nashville....	Union Bk. of Tenn.....	John Kirkman.....	James Correy	2,017,284
Chattanooga..	" " Branch	J. G. Glass.....	J. Correy, Jr.	200,000
Columbia.....	" " "	William Park.....	S. A. Hamner.....	150,000
Memphis	" " "	A. R. Herron.....	Frederick W. Smith..	150,000
Knoxville....	" " "	J. H. Cowan	John Craig.....	150,000
Jackson	" " "	.....	F. H. McNight, *agent.*	200,000
Memphis	*Southern Bank.....	W. J. Davie	W. S. Macrae	500,000
Lawrenceb'rg	Lawrenceburg Bank..	S. E. Rose	William Simonton....	100,000
	Total 36 *Banks.*	*Circulation* $4,900,000.	*Specie* $2,300,000.	$11,627,197

* Free Banks.

Figure A.2. The Merchant's and Banker's Almanac: Tennessee banks. This figure illustrates that 16 out of a total of 36 Tennessee banks in 1855 were free banks according to the *Merchant's and Banker's Almanac*, 1856 edition.

References

Bodenhorn, H. (2006). Bank chartering and political corruption in antebellum New York: Free banking as reform. In E. L. Glaeser and C. Goldin (Eds.), *In Corruption and Reform: Lessons from America's Economic History*, pp. 231–257. University of Chicago Press.

Cornelius, J. (1969). *A History of Constitution Making in Illinois*. Urbana, Il: Institute of Government and Public Affairs, University of Illinois of Urbana-Champaign.

Du, D. (2010). Illinois free banks, 1851–1865. *Business and Economic History 8*.

Erickson, E. A. (1969). A history of the Miners' Bank of Dubuque, 1836–1845. *Annals of Iowa 39*(8), 619–639.

Gandhi, A. (2003). Antebellum banking regulation: A comparative approach. Ohio State University Working Paper.

Gras, N. S. B. (1937). *The Massachusetts First National Bank of Boston, 1784–1934*. New York: Arno Press.

Hammond, J. D. (2006). *The History of Political Parties in the State of New-York, from the Ratification of the Federal Constitution to December, 1840*. M Publishing.

Huntington, C. C. (1915). *A History of Banking and Currency in Ohio before the Civil War*. Columbus, Oh.: The F.J. Heer Printing Co.

Lamoreaux, N. R. (1996). *Insider Lending: Banks, Personal Connections, and Economic Development in Industrial New England*. Cambridge University Press.

Murphy, S. A. (2017). Free banking in Louisiana. Tobin Project Conference on Democracy Working Paper.

New York State Senate (1825). *Journal of the Senate of the State of New York, at Their Forty-Eighth Session*. Albany: E. Croswell, Printer to the State.

OCC (1876). *Annual Report of the Comptroller of the Currency*. Washington Government Printing Office.

Rockoff, H. (1974). The free banking era: A reexamination. *Journal of Money, Credit and Banking 6*(2), 141–167.

Sumner, W. (1896). *A History of Banking in the United States*. Hist. of Banking in all the leading nations. Create Space Independent Publishing Platform.