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Financial stability policies and bank lending: quasi-experimental evidence from Federal Reserve interventions in 1920-21

by
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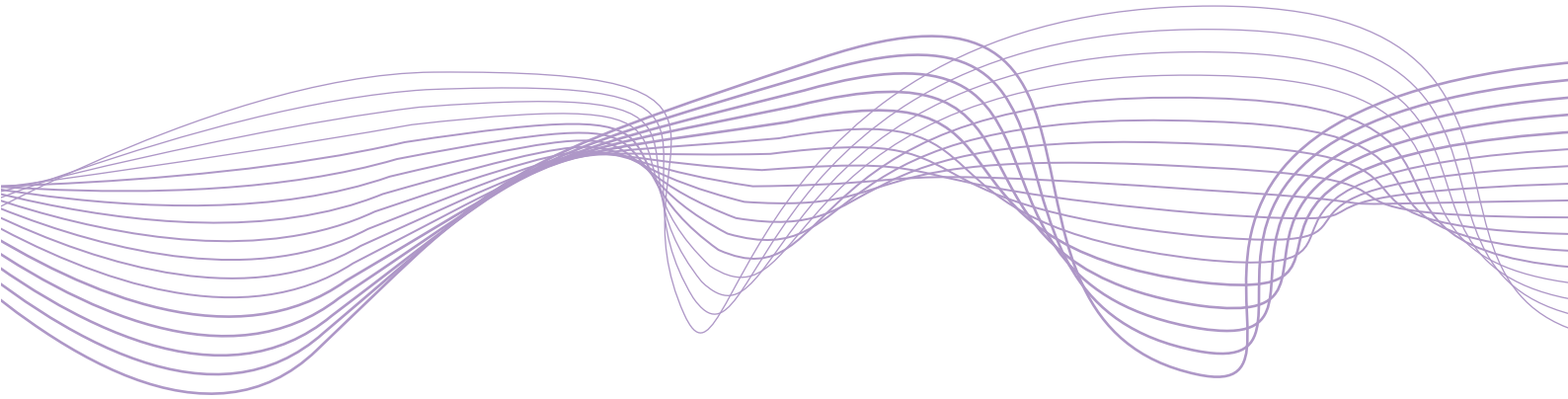

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European Systemic Risk Board
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Abstract

I estimate the comparative causal effects of monetary policy "leaning against the wind" (LAW) and macroprudential policy on bank-level lending and leverage by drawing on a single natural experiment. In 1920, when U.S. monetary policy was still decentralized, four Federal Reserve Banks implemented a conventional rate hike to address financial stability concerns. Another four Reserve Banks resorted to macroprudential policy with the same goal. Using sharp geographic regression discontinuities, I exploit the resulting policy borders with the remaining four Federal Reserve districts which did not change policy stance. Macroprudential policy caused both bank-level lending and leverage to fall significantly (by 11%-14%), whereas LAW had only weak and, in some areas, even perverse effects on these bank-level outcomes. I show that the macroprudential tool reined in over-extended banks more effectively than LAW because it allowed Federal Reserve Banks to use price discrimination when lending to highly leveraged counterparties. The perverse effects of the rate hike in some areas ensued because LAW lifted a pre-existing credit supply friction by incentivizing regulatory arbitrage. My results highlight the importance of context, design and financial infrastructure for the effectiveness of financial stability policies.

JEL classifications:
E44, E51, E52, E58, G21, N12, N22

Keywords:
monetary policy, macroprudential policy, leaning against the wind, progressive discount rate, credit boom, bank lending, leverage, financial crisis, Federal Reserve System, recession of 1920/1921

1 Introduction

Credit booms can amplify business cycle fluctuations by fueling excessive credit growth for local conditions (Rey, 2013; Borio, 2014). When they "go bust", credit booms tend to end in financial crises which inflict large costs on creditors, tax payers and the real economy (Cerra and Saxena, 2008; Schularick and Taylor, 2012; Romer and Romer, 2017). These pecuniary and aggregate demand externalities of unconstrained credit growth provide a clear rationale for financial stability policy (Stein, 2012; Farhi and Werning, 2016; Martinez-Miera and Repullo, 2019; Caballero and Simsek, 2020). Reignited by the Great Financial Crisis of 2008-09, the question which precise measure should be deployed to rein in financial excesses, however, remains subject to an ongoing debate (Gambacorta and Signoretti, 2014; IMF, 2015; Svensson, 2016, 2017; Gourio et al., 2018; Schularick et al., 2020). Should central banks "lean against the wind"[1] (LAW) using their conventional interest rate or are more targeted macroprudential tools[2] better suited to tame bank lending?

Policy endogeneity, regulatory arbitrage, and the fact that the two policy options are rarely employed simultaneously explain why empirical work on their relative effectiveness has proven elusive so far. The present paper addresses this gap in the literature. I estimate the comparative causal effects of monetary policy leaning against the wind and macroprudential policy on bank-level lending and leverage by exploiting a single natural experiment. To identify the causal effect of the policies, I draw on geographic policy discontinuities across U.S. Federal Reserve district borders, at a time when each of the twelve Federal Reserve Banks still had the power to conduct independent monetary policies. In late spring 1920, four Federal Reserve Banks (Boston, Chicago, Minneapolis and New York) leant against the wind by hiking their interest rate from 6% to 7% to address financial stability concerns. Four other Reserve Banks (Atlanta, Dallas, Kansas City and St Louis) used a macroprudential tool to safeguard financial stability, while keeping their baseline policy rate constant at 6%. Both financial stability policies were implemented in late May/early June 1920 and they remained in place until late June/early July 1921. The remaining four districts (Cleveland, Philadelphia, Richmond and San Francisco) never changed their policy stance and simply maintained the prevailing 6% rate (Figure 1).

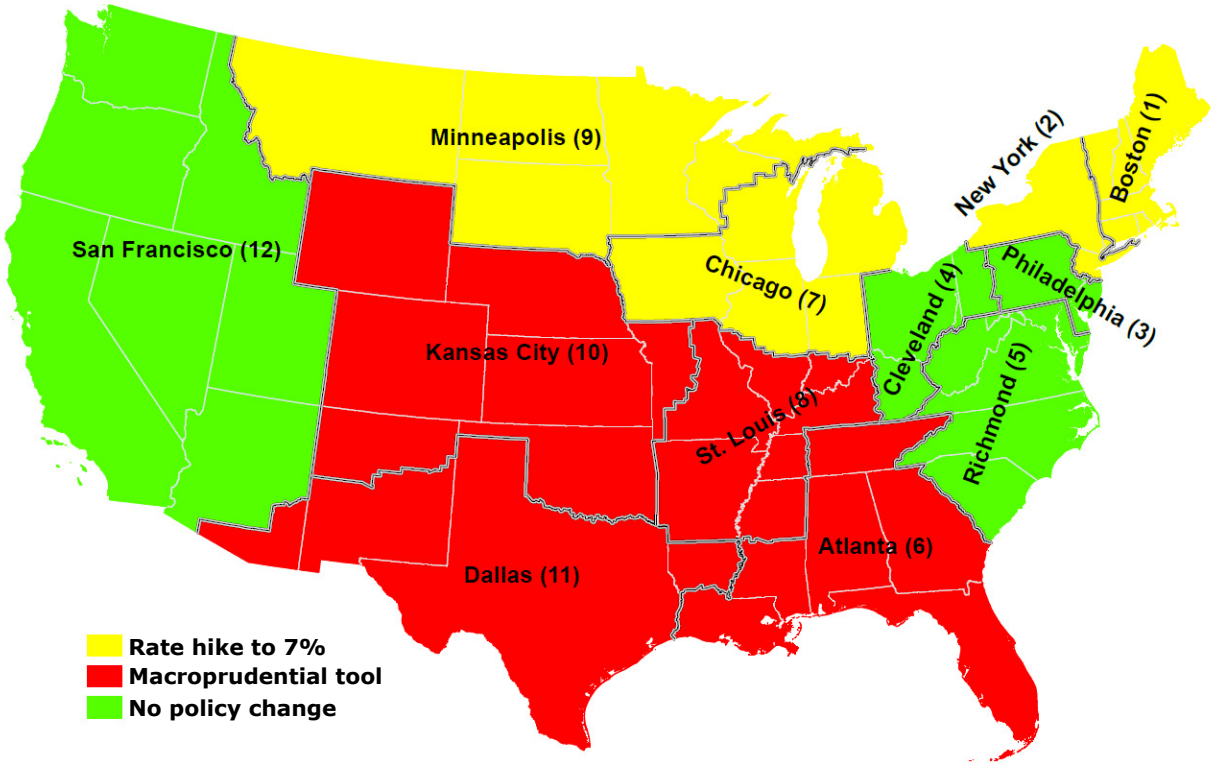
My identification strategy builds on a unique institutional setting. First, although the different policy choices were endogenous to aggregate financial developments in the twelve Federal Reserve districts, my discontinuity design compares treated and control group banks in close bandwidths of 25 kilometers around borders of districts with different policies.[3] Within these bands, bank-level characteristics and local economic conditions exhibit statistically identical pre-treatment levels and pre-trends. The homogeneity in baseline characteristics minimizes the risk of omitted variable bias and allows me to disentangle supply-side from demand-side drivers of bank lending. Second, banking laws established a uniform regulatory framework for national banks across the entire

[1] When "leaning against the wind", central banks raise their conventional monetary policy instrument, the nominal interest rate, to steer against financial market developments deemed unsound. More precisely, LAW is defined as "monetary policy that is somewhat tighter (that is, with a somewhat higher policy interest rate) than what is consistent with flexible inflation targeting without taking any effects on financial stability into account"(Svensson, 2017, p.193).

[2] Macroprudential policies represent targeted tools designed to address the build-up of systemic risks in the financial system or some of its sub-sectors (e.g. loan-to-value ratios, reserve requirements and countercyclical buffers).

[3] I also provide results for the full sample, and 200, 100, 75 and 50km bandwidths around the borders.

Figure 1: Federal Reserve Bank policies adopted in late spring 1920



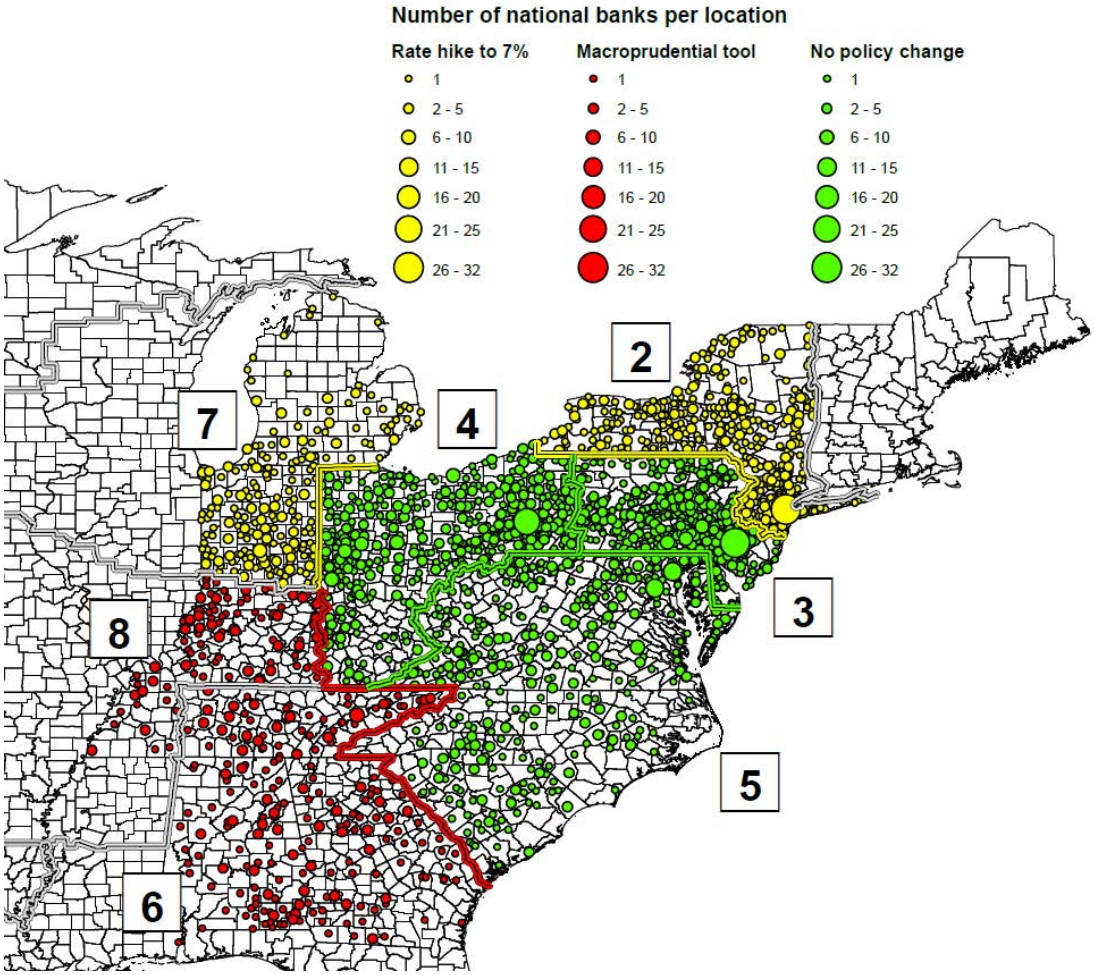
Source: Federal Reserve Board (1921)
This map shows the different policies adopted by Federal Reserve districts in late spring 1920.

territory of the United States (Mitchener, 2005). Hence, my setting rules out spurious correlation concerns related to legal discontinuities in bank regulation and supervision. Third, the U.S. banking system in the 1920s was characterized by a combination of *de jure* and *de facto* financial segmentation. National banks did generally not have the right to establish branches (Carlson and Mitchener, 2006, 2009). As "unit banks", they operated predominantly within strict geographic confines (Jaremski and Wheelock, 2020a). The Law also forbade national banks to borrow from Federal Reserve Banks (and their branches) outside their district. Moreover, I can show that national banks did not sort across borders in anticipation or in reaction to policy differences. Finally, the borders of the twelve Federal Reserve districts were explicitly designed to ringfence large parts of the existing interbank links between bank locations (Jaremski and Wheelock, 2017). The prevailing financial segmentation thus significantly limited the scope for regulatory arbitrage which complicates the identification of causal effects in modern settings.

I exploit almost 13,000 bank-level balance sheets for the period between September 1919 and September 1921, newly hand-collected from the annual Office of the Comptroller of the Currency (1920, 1921a,b, 1922) reports, Rand McNally bankers directory (1920, 1921a,b) and individual national bank examiner reports located at the U.S. National Archives at College Park, Maryland. My bank-level panel data covers large parts of the East Coast of the United States (Federal Reserve districts 2 to 8, see Figure 2) which provides borders for all relevant policy combinations (including Placebo borders with identical policies). Controlling for time and bank fixed effects, I find that macroprudential policy caused both lending and leverage to fall significantly relative to districts without a policy change. Treatment led to a reduction in both outcome variables by between 11% and

14%. The conventional interest rate hike had a differential impact depending on which borders are considered. In the West (district 7, Chicago), the policy marginally eased credit pressures by around -1%, but the coefficients are not statistically different from zero. In contrast, in the second district (New York), LAW had a perverse effect on bank-level outcomes: leaning against the wind increased both lending and leverage by between 8% to 9% relative to control group banks.

Figure 2: Locations of national banks included in sample (color-coded for different policies)



Source: Rand McNally bankers directory (1920); OpenCage Geocoder
This map shows all national bank locations (incl. the number of banks in each location) contained in the sample of this study.

These results are robust to a wide range of falsification checks. Apart from changes in the specifications, the computation of standard errors and the inclusion of control variables, I conduct a series of Placebo tests to verify that treatment effects do not exist before treatment began and do not persist after treatment ended. Furthermore, I show that there are no systematic discontinuities across district borders with identical policies. Building on Richardson and Troost (2009), I also limit my sample to bank-level data from states which were split by Federal Reserve district borders to show that my estimates are not merely driven by other (economic) policy discontinuities across state borders unrelated to LAW or macroprudential policy. Finally, the split border specification enables me to implement a Placebo test drawing on state-chartered non-member banks.[4] Since these banks could not borrow from the Federal Reserve System, they should not have been affected by the policies

[4] All national banks automatically became member banks of the Federal Reserve System when the System was founded in 1914. State-chartered banks could opt in and become members on a voluntary basis.

to the same degree.[5] I find that the policies had no statistically significant treatment effects on non-member banks.

To identify the mechanisms driving my empirical results, I proceed in two steps. First, I show that the specific macroprudential policy used in 1920-21 equipped Federal Reserve Banks with a stronger and more targeted tool to exert pressure on over-leveraged counterparties than LAW. In 1920, monetary policy transmission functioned through the so-called "reserves channel" (Carlson and Duygan-Bump, 2018).[6] The primary motive for borrowing from a Federal Reserve Bank was to make good on reserve requirements: member banks had to hold reserves against their deposit liabilities and all reserves needed to be stored with the Reserve Banks. When a commercial bank granted a new loan to a customer, it usually created a deposit for the borrower. This increase in deposits meant a higher absolute reserve requirement and implied borrowing from the Federal Reserve Bank to abide by the new requirement.[7] Both LAW and the macroprudential tool increased the marginal cost of reserves and thus acted upon banks' incentive to grant new loans. The rate hike translated into a 100 basis point flat increase in the marginal cost, irrespective of the amount a member bank wanted to borrow. In contrast to LAW, the macroprudential tool - officially named the "progressive discount rate" (PDR) - turned the cost of new borrowing from the Federal Reserve Bank into a function of a bank's current level of outstanding borrowings from the Reserve Bank relative to a maximum credit line. The maximum line was calculated for each bank on the basis of its reserves and capital position. The more a given bank was already borrowing, the higher the interest rate became it was charged for additional loans from its Reserve Bank. The rate increased by 50 basis points for every 25% a member bank borrowed in excess of its basic line. Thus, the macroprudential tool endowed Federal Reserve Banks with the power to exercise price discrimination against banks they regarded as over-leveraged.

The design of the PDR clarifies why macroprudential policy was more successful in taming banks' credit expansion, but it does not explain the perverse treatment effect of LAW in the second district. Hence, in a second step, I investigate why the New York district experienced higher credit growth and leverage in response to the conventional interest rate hike. One plausible explanation relates to the differences in prevailing state usury rates along the Eastern and Western LAW borders (Ryan, 1924). The maximum legal rate was 6% in the East (districts 2 and 3) and 8% in the West (districts 4 and 7). When usury rates are binding, they can introduce a credit friction preventing banks from adequately pricing riskier lending: higher risk projects cannot get funding, although demand for more loans at increased rates exists (Temin and Voth, 2008). Usury rates thus accelerate the advent of quantity rationing in credit markets as described by Stiglitz and Weiss (1981). I collected bank-level interest rate data from individual bank examiner reports which show that the 6% usury

[5] Anderson et al. (2018) show that state-chartered banks partly circumvented this restriction by borrowing via their correspondent national banks. Overall, however, state-chartered banks' access to discount window finance was likely significantly curtailed relative to member banks.

[6] The Federal Reserve Banks' credit facilities constituted so called "standing facilities" which relied on banks to initiate the interaction with the central bank. Before the mid-1920s, Federal Reserve Banks did not engage in open-market operations to make their policy rates effective.

[7] In 1920, borrowing from the Federal Reserve System could take two different forms. First, it could mean the *rediscount* of bills of exchange (strictly speaking, the sale of bills at a discount). Second, borrowing could take the form of collateralized loans (*advances*, also called *bills payable*).

rate on local loans was highly binding for banks located in district 2 before the LAW policy was introduced, whereas banks in district 7 charged rates considerably below the maximum ceiling of 8% (but on average 80 basis points above 6%). With binding usury rates, the introduction of LAW in district 2 incentivized banks to seek alternatives to local loans which were not subject to usury rates. I show that banks reacted to treatment by increasing their call loans to the New York City stock exchange and by purchasing outside commercial paper. Channeling funds into these alternative investments allowed banks to charge higher average interest rates and to increase overall outstanding credit volumes.

The paper is organized as follows. In the next subsection, I discuss my contributions to the different strands of literature related to this study. Section 2 describes my primary sources and presents the new data sets compiled for this paper. Section 3 discusses experiment validity based on the historical background of this study and explains my identification strategy in detail. Section 4 provides the empirical results and robustness checks. Section 5 investigates the channels of policy transmission. Section 6 concludes. A detailed online appendix complements the paper.[8]

Contributions to the literature

This study relates to several literatures. First, I contribute to the current debate on the choice of optimal financial stability policies (Gambacorta and Signoretti, 2014; Gourio et al., 2018; Svensson, 2016, 2017; Martinez-Miera and Repullo, 2019; Bergant et al., 2020; Schularick et al., 2020). Existing theoretical studies reach opposing conclusions on the relative merits of LAW and its macroprudential alternatives.[9] Whereas LAW famously "gets into all cracks" of both regulated and shadow financial sectors (Stein, 2013), macroprudential tools are less likely to cause collateral damage[10] but they are more prone to regulatory arbitrage and more difficult to deploy[11] (Smets, 2014). To my knowledge, my paper is the first to stage a true empirical "horse race" between the two types of policies while fixing time and environment. Running a similar test is hardly possible with modern data because most policy-makers consider LAW and macroprudential policies as substitutes rather than complements.[12] Moreover, I exploit conditions of swift macroprudential policy deployment and limited arbitrage under which there is no clear *a priori* case for LAW. This special setting allows me to disentangle other

[8] The online appendix can be downloaded here. The appendix is also attached to this working paper after the list of references (following page 56).

[9] Most recent contributions use DSGE models (Gambacorta and Signoretti, 2014; Gourio et al., 2018) or static cost-benefit analysis (Svensson, 2016, 2017) to model the impact of LAW. These two approaches cannot be easily mapped into each other *and* the authors reach different conclusions. While the former suggest LAW can be a first-best policy response in some scenarios, the latter argues in favor of more targeted prudential policies because the costs of "leaning against the wind" almost always outweigh its benefits. On the empirical side, Schularick et al. (2020) draw on long-run historical data to argue that LAW policies during credit and asset price booms are more likely to trigger crises than to prevent them. Bergant et al. (2020) show that macroprudential policies are more effective than capital controls when it comes to dampening global financial shocks.

[10] Monetary policy tightenings have costs in terms of higher inflation volatility, foregone output and employment. Incorporating financial stability into the monetary policy reaction function can therefore lead to trade-offs between price stability and financial stability with direct macroeconomic consequences (IMF, 2015). By weakening the economy, LAW may even become counterproductive. The economy faces future negative shocks in a more fragile state, potentially implying higher costs during future crises than without the preemptive rate increase (Svensson, 2017).

[11] Macroprudential tools are more difficult to adjust and deploy than conventional monetary policy because they often require legal changes and direct political voting/backing.

[12] Recent theoretical advances show, however, that it is possible to design optimal policy mixes (Farhi and Werning, 2016; Collard et al., 2017).

caveats against LAW, which are independent of the greater collateral damage it may cause. I show not only that macroprudential policy can be more effective than conventional monetary policy in taming bank credit, but also that LAW can have severe counterproductive effects. My results highlight the importance of context, design and financial infrastructure for the effectiveness of financial stability policies.

Second, my paper contributes to the existing empirical literature on the effects of financial stability policies in two distinct ways. On the one hand, my results relate to earlier studies on the mechanics of regulatory arbitrage (Aiyar et al., 2014; Reinhardt and Sowerbutts, 2017; Forbes, 2019; Araujo et al., 2020).[13] I show that pre-existing credit frictions can lead to dynamics that obviate the dampening effect of LAW on bank credit by incentivizing alternative lending. On the other hand, my research design addresses an often overlooked identification challenge for recent empirical work on the impact of financial stability policies (e.g. Barroso et al. (2017); Camors et al. (2017); Jiménez et al. (2017); Alam et al. (2019)).[14] Treated credit institutions may try to circumvent policy-induced higher refinancing costs by borrowing from control group banks. On the "benign" side, this reaction can bias treatment effects towards zero, turning available estimates into lower bound effects.[15] Regulatory arbitrage, however, triggers an increase in the (interbank) loan portfolio of banks in the control group. Studies which use other financial intermediaries as control groups may therefore suffer from violations of the stable unit treatment value assumption (SUTVA). As a corollary, treatment coefficients for total lending outcomes may be biased upwards if regulatory arbitrage causes lending by control group banks to increase by more than for treated banks. For example, an upward bias could materialize if treated banks only lend out a fraction of the funds they receive by borrowing from untreated peers, while holding the remainder as liquid reserves.

The unique setting of this paper works as a first line of defense against this form of SUTVA violation. As Jaremski and Wheelock (2017) argue, the very design of the Federal Reserve districts aimed at ringfencing interbank networks into separate districts. To prove this point, I hand-collected the universe of interbank correspondent links for the banks in my sample (>35,000 links) from the Rand McNally bankers directory (1920). The network data allows me to check whether the interbank connections of treated banks in my sample could have induced SUTVA violations in my local discontinuity models. Consistent with the pyramid structure of the U.S. interbank network structure at the time (Mitchener and Richardson, 2013; Anderson et al., 2018; Mitchener and Richardson, 2019; Jaremski and Wheelock, 2020b), I find that links to local banks across the

[13] Aiyar et al. (2014) show that time-varying, bank-specific capital requirements were effective in harnessing credit growth in the United Kingdom but also led to regulatory arbitrage via non-regulated banks. Reinhardt and Sowerbutts (2017) document differential regulatory arbitrage behavior in a large cross-country panel, depending on the type of macroprudential tool used. Tighter domestic capital regulation induces domestic non-banks to borrow from foreign banks, whereas stricter lending standards have no such effects. Forbes (2019) and Araujo et al. (2020) conduct meta-analyses revealing evidence of leakages and spill-overs in available estimates.

[14] Jiménez et al. (2017) find that dynamic provisioning proved an effective policy tool to tame over-leveraged banks in the Spanish case. A long series of hitherto unpublished working papers (for example, c.f. Barroso et al. (2017), Camors et al. (2017) and Reinhardt and Sowerbutts (2017)) provide similar evidence using credit register data from a variety of countries. A more exhaustive list of relevant contributions can be found in the conference proceedings of the BIS CCA CGDFS Working Group closing conference on "The impact of macroprudential policies: an empirical analysis using credit registry data" (June 2016). Alam et al. (2019) use an IMF database of macroprudential policies to highlight the nonlinear effects of LTV tightenings.

[15] Interference might also occur among treated units if the intensity of treatment varies across banks, as e.g. under the PDR. In this case, interbank borrowing likely triggers a downward bias in the coefficient, stacking the cards against finding a significant treatment effect.

nearest Federal Reserve district border were practically non-existent. This constellation makes an upward bias in my local discontinuity regressions highly unlikely.[16]

Third, my paper provides new insights regarding the design of effective financial stability policies. Ultimately, the relative effectiveness of LAW and alternative policies rests on their successful transmission to the financial sector.[17] The transmission mechanism of LAW and macroprudential policy in my setting closely resembles an idea put forward in a seminal paper by Stein (2012). Stein (2012) proposes designing financial stability policies based on the introduction of a system of cap-and-trade permits to regulate banks' money creation. This system can be implemented by making use of existing reserve requirements for short-term liabilities.[18] In my historical setting, LAW and macroprudential policy were both directly transmitted to bank balance sheets because they increased the marginal cost of reserves. My contribution thus closely corresponds to a tailored empirical test of two different implementations of Stein's (2012) proposal.[19] In addition, the design of the progressive discount rate in 1920-21 caused the marginal cost of reserves to become a function of individual banks' leverage. My findings reveal that this form of customized price discrimination against central bank counterparties was highly effective in reducing bank-level leverage and credit growth, whereas LAW was not. Central bank price discrimination represents one of the elephants in the discussion room where LAW and its alternatives are currently debated. The results in this paper suggest that policy-makers may gain from initiating a conversation on the benefits and costs of rules-based price discrimination in the context of their financial stability mandates.[20] This conclusion particularly applies to emerging market economies, where reserve requirements remain an important lever of monetary policy (Cordella et al., 2014).

Fourth, this paper adds new complementary insights to recent economic history contributions relevant to my quasi-experimental setting. Whereas Tallman and White (2020) take a macroeconomic perspective focusing on aggregate credit developments within Federal Reserve districts in 1920-21, I provide a micro-data based econometric analysis of the causal effects of financial stability policies on bank credit. My findings showcase the Federal Reserve System's early use of sophisticated macroprudential tools, in line with the System's pre-occupation with the quality and quantity of bank credit at the time (Rotemberg, 2013). Following an earlier contribution by Wallace (1956), Tallman and White (2020) argue that interdistrict borrowing between Federal Reserve Banks allowed districts to re-allocate credit capacity across regions, thereby preventing a banking panic during the recession of 1920-21. Tallman and White (2020) categorize expansionary and hawkish Federal Reserve

[16] Most banks entertained correspondents in Eastern financial centers (Chicago, Cleveland, New York, Philadelphia) which were generally located further away from the district borders. Although correspondent links to major financial centers may have helped treated banks to circumvent the policies, this arbitraging behavior likely turns my estimates into lower bound effects: it does not artificially blow up the total lending portfolio of the very local control group banks in my sample but only affects control group banks further away from the border line. Moreover, my bank fixed effects specifications directly control for the number and nature of banks' correspondent links, because interbank connections were very "sticky" at the time.

[17] A large variety of potential transmission channels has been explored in the literature and a detailed discussion is beyond the scope of this paper (c.f. IMF (2015) for a survey).

[18] Required reserves represent the permits and the cost of permits is dictated by the central bank policy rate (i.e. the marginal cost of reserves).

[19] Stein (2012) builds his theoretical case for LAW on the existence of a market failure: financial institutions over-issue short-term debt because they do not take into account the negative externalities of asset fire sales in distressed times (c.f. also Gorton and Ordoñez (2014) and Oehmke (2014)).

[20] Rules-based price discrimination was part of the day-to-day business in nineteenth century central banking practice (Wood, 1939; Anson et al., 2017). New Zealand, Japan and the Eurozone have recently implemented interest rate tierings to enhance the transmission of monetary policy and to limit the negative side effects of negative interest rates.

Banks according to the total amount of liquidity provided to member banks in each district. Intriguingly, four out of the five most expansionary districts in their aggregate analysis had implemented the progressive discount rate in 1920. Together, our contributions thus suggest that an ample liquidity provision in the aggregate, coupled with the use of the PDR targeting over-leveraged banks, constituted a successful policy mix in 1920-21.

In other work related to my study, Carlin and Mann (2019) draw on county-level data from Illinois to explore the real effects of the Federal Reserve System's interest rate policy during the recession of 1920-21. Their paper suggests that higher interest rates may have had short-term costs causing agricultural hardship, but also long-term benefits in terms of lowering debt-to-output levels until the Great Depression. These insights shed valuable light on the short-run vs. long-term trade-offs of financial stability policies. In contrast to Carlin and Mann (2019), I exploit bank-level data from districts 2 to 8 to dis-aggregate the Federal Reserve System's policy stance at the time. Building on Goldenweiser (1925) and Wallace (1956), my paper highlights that the various Federal Reserve Banks implemented different policies with quite heterogeneous effects on bank credit.[21] I explain the rationale underlying the different policy choices and I provide detailed evidence on their transmission mechanisms. Moreover, I show that (identically sized) interest rate increases led to very different outcomes depending on the district one examines. My paper thus raises the question whether the interesting findings regarding the real costs of policies provided by Carlin and Mann (2019) also apply to areas where LAW appears to have had perverse effects on bank credit.

Finally, I extend the methodology of seminal papers by Richardson and Troost (2009) and Jalil (2014) who exploit historical Federal Reserve border discontinuities to show that liquidity provision by the Federal Reserve System mitigated banking panics during the Great Depression of the 1930s. My study differs from theirs along several dimensions. I study the effects of explicit monetary policy and macroprudential policy decisions rather than implicit differences in the willingness of Federal Reserve Banks to provide emergency liquidity. Furthermore, I analyze an earlier episode at the beginning of the 1920s when the Federal Reserve System was still in its infancy, the stigma on discount window borrowing was limited at best, and the economic environment was initially characterized by a strong boom rather than a severe depression (Gorton and Metrick, 2013; Anbil, 2018).[22] I also exploit several so far unexplored border discontinuities on the East coast of the United States which hosted both large financial centers and a much higher number of banks than the southern districts studied in previous contributions. Finally, to the best of my knowledge, I am the first to provide actual quantitative evidence backing the crucial non-interference assumption based on interbank network data. This assumption needs to hold to allow for the identification of unbiased effects of Federal Reserve policies on bank credit using district border discontinuities before 1935.

[21] In fact, Illinois represents a state split between district 7 (Chicago) and district 8 (St Louis). The two districts implemented different policies in 1920-21 (LAW in district 7 and PDR in district 8), which also explains why - despite an overall increase relative to 1919 - substantially different baseline discount rates prevailed in the two districts (7% in district 7 and 6% in district 8).

[22] The literature on multiplier effects suggest that differences in the underlying setting influence the size of treatment effects. For a recent example, c.f. Hausman (2016).

2 Data

This paper combines several hand-collected and newly digitized historical data sets. First, I compiled a bank-level panel data set containing balance sheet information for all national banks located in the following 17 states: Alabama, Delaware, District of Columbia, Georgia, Indiana, Kentucky, Maryland, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia. The bank-level panel data set contains 3,334 individual banks which are observed at four points in time, yielding a total of 12,996 observations.[23] I track national banks on four call dates: 12 September 1919, 31 January 1920, 8 September 1920 and 6 September 1921. I rely on two sources to collect the balance sheet data. For the September call dates, I use the annual reports of the Office of the Comptroller of the Currency (1920, 1921a,b, 1922) and for the January 1920 call date I draw on the Rand McNally bankers directory (1920) bankers directory.[24] The four call dates are partly dictated by data availability. The Comptroller reports were published only once a year with individual bank-level data recorded in September, while the bankers directory was published bi-annually (in January and July). I also sampled call dates specifically in order to satisfy the data needs of my research design. The January 1920 data contain the last available balance sheet information before LAW and macroprudential policy implementation in late May/early spring 1920. Together, the September 1919 and January 1920 call dates enable me to analyze pre-trends.

I concentrate on banks located in the 17 states on the U.S. East Coast for several reasons. First, this region is home to all policy border discontinuities relevant for this study. The Federal Reserve district borders between the districts of New York and Philadelphia as well as Cleveland, but also the border line between the Cleveland district and the Chicago district, reflect policy discontinuities between LAW districts and Federal Reserve Banks which did not change policy stance (see Figure 1). In contrast, the district borders in the South separate Federal Reserve districts which implemented the PDR (Atlanta and St Louis) and Federal Reserve districts which kept their policy stance unchanged (Richmond and Cleveland). Furthermore, I exploit a third (non)discontinuity in my robustness checks. I draw on the borders between the Cleveland, Philadelphia and Richmond districts for Placebo tests, because none of these three districts implemented policy changes in late spring 1920. The second reason for concentrating on the 17 states mentioned above is that only very few national banks were located close to the district borders in the Western part of the United States (Jaremski and Wheelock, 2017, c.f. their Figure 1 on p.24). The border line between the San Francisco district on the one hand and the Dallas, Kansas City and Minneapolis districts on the other hand is mostly located in the Rocky Mountains. The inclusion

[23] Some banks fail or are founded after September 1919 which explains why my sample is not fully balanced.

[24] Both sources are freely accessible on-line (FRASER, Office of the Comptroller of the Currency reports and HathiTrust, Rand McNally bankers directory; last accessed 14 July 2020). The annual reports list six asset side positions (loans and discounts; government securities; other bonds and investments; lawful reserve; cash and exchanges; other assets) and six liabilities side positions (paid-up equity; surplus and undivided profits; circulation; demand deposits; time deposits; due to banks and other liabilities) for each national bank. The reports also indicate the sum of total assets. Rand McNally bankers directory (1920) provides information on at least five positions for each bank (paid-up equity; surplus and undivided profits; deposits including due from banks; loans, discounts, bonds and securities; cash, exchanges and due from banks) and more disaggregate data on banks located in central reserve cities, Federal Reserve branch cities and other large financial centers. To compare bank-level variables over time, I merge positions from the Comptroller reports to match them exactly to the positions in the bankers directory published by Rand McNally bankers directory (1920). For example, to mirror the aggregate loan and investment portfolio in the bankers directory, I take the sum of the following positions from the Comptroller reports: loans and discounts; government securities; other bonds and investments.

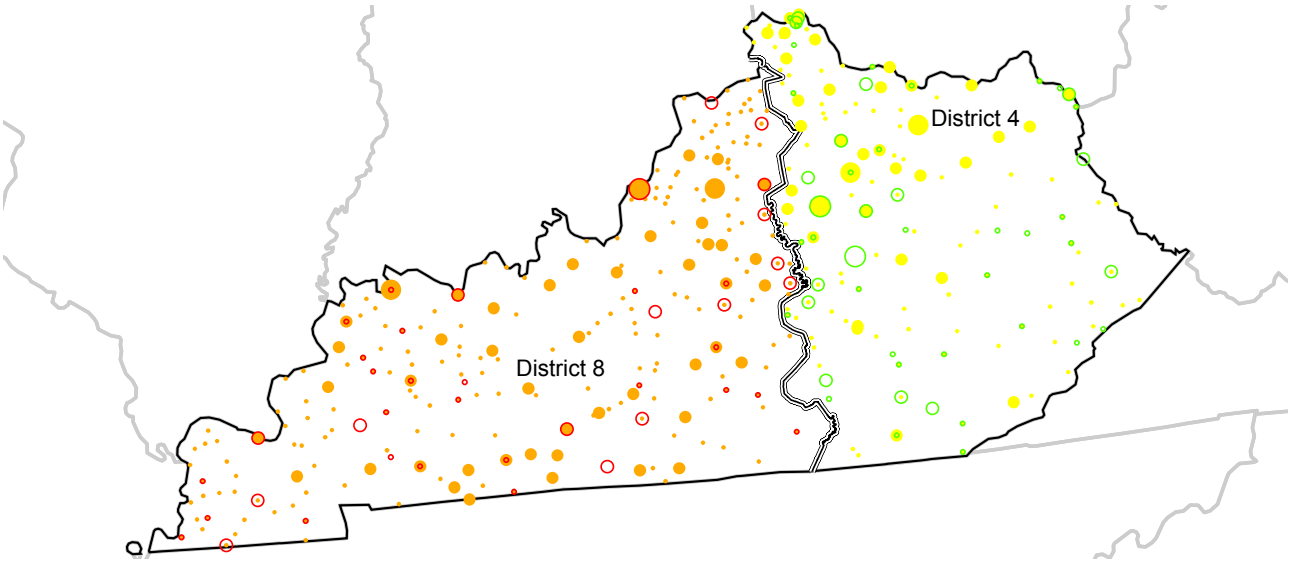
of banks in locations far away from the border line would likely violate crucial identification assumptions of my local discontinuity design (see next section). The third reason for limiting my sample to the 17 states listed above – as opposed to including banks located in additional states on the East coast as, for example, Massachusetts or Florida – is that I focus on states which have at least one bank domiciled at a distance smaller than 200 kilometers from the relevant Federal Reserve district border. Using geographic information system (GIS) software, I geo-located all national banks in my sample to obtain their airline distance (in kilometers) to relevant Federal Reserve district borders whose geographic location I also geocoded.

Kentucky and New Jersey represent two states of particular interest in my sample because their territories are split between two Federal Reserve districts with different financial stability policies starting in spring 1920. The Western part of Kentucky is located in district 8 (St Louis, a macroprudential policy district), whereas the state's Eastern half forms part of district 4 (Cleveland, a no policy district). New Jersey in turn is divided into a Northern part located in the New York district which lent against the wind in spring 1920, and a Southern part belonging to district 3 (Philadelphia, again a non-policy district). I apply my local discontinuity framework to split-state banks to show that my estimated treatment effects are not spuriously driven by differences in other state-level economic policies/regulations. For these two states, I compiled bank-level data for the whole population of commercial banks (state-chartered banks and national banks), including information on whether a given state-chartered bank was a member of the Federal Reserve System. In addition to the four call dates listed above, I collected balance sheet data on split state national banks for 31 January 1921 and 31 July 1921 (both from the Rand McNally bankers directory (1921a,b)). For state-chartered banks I gather balance sheets for the call dates in January 1920 and January 1921. These additional data enable me to conduct Placebo tests checking whether treatment effects for member banks persisted after treatment had ended and whether non-member banks were affected by the policies. Figures 3 and 4 plot the split state data. Together the split state samples contain data for about 700 individual state-chartered banks, which I collected on top of the data for the 3,334 national banks mentioned above.

Apart from my main panel data sets, I also compile two new complementary bank-level data sets. The first complementary data set contains all interbank connections (so called "correspondent links") for the national banks in my sample, as published by the Rand McNally bankers directory (1920) bankers directory in January 1920. I collected the names of more than 35,000 banks which served as correspondents for the national banks in my sample. I also geo-coded the correspondents' geographic location in the United States. Hence, for each national bank in my sample, I am able to differentiate between correspondents according to whether they were domiciled in a Federal Reserve district subject to LAW, to the PDR, or belonged to one of the districts which did not change policy stance. I draw on these interbank network data to check for the presence of local continuity regarding banking connectedness and to assess whether my econometric results are likely to suffer from SUTVA violations.

Second, based on individual national bank examiner reports available at the U.S. National Archives at

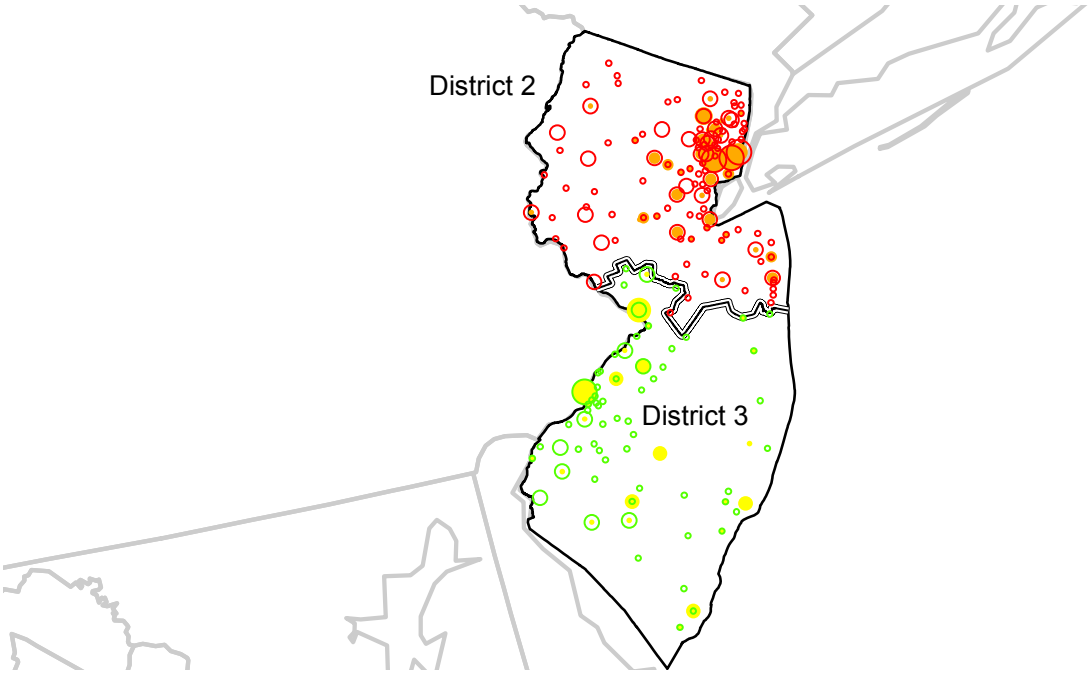
Figure 3: Banks located in the split state of Kentucky



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

This graph plots the location of all commercial banks in the split state of Kentucky. The four marker symbols represent treated Federal Reserve member banks (red hollow circles), Federal Reserve member banks in the control district (hollow green circles), non-member banks in the treated district (full orange circles), and non-member banks in the control district (full yellow circles). The different sizes of hollow/full circles represent the number of banks of a particular category in a given city (the smallest circles represent a single bank, the medium sized circles indicate locations with 2-4 banks and the largest circles stand for cities with 5-9 banks.

Figure 4: Banks located in the split state of New Jersey



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

This graph plots the location of all commercial banks in the split state of New Jersey. The four marker symbols represent treated Federal Reserve member banks (red hollow circles), Federal Reserve member banks in the control district (hollow green circles), non-member banks in the treated district (full orange circles), and non-member banks in the control district (full yellow circles). The different sizes of hollow/full circles represent the number of banks of a particular category in a given city (the smallest circles represent a single bank, the medium sized circles indicate locations with 2-4 banks and the largest circles stand for cities with 5-9 banks. In the case of non-member banks located in the treated region, there is a fourth category (10-15 banks) containing the two largest cities in terms of banks (Jersey City and Newark).

College Park, Maryland, I assemble bank-level interest rates and loan portfolio decompositions for all national banks located in Indiana, Kentucky and New Jersey. I concentrate on reports for examinations which took place throughout 1920. Although the pacing and frequency of examinations differs from bank to bank, many national banks were examined at least twice in 1920 – once before and once after the introduction of financial stability policies. I use these micro data sets to trace the transmission channels explaining the size and sign of treatment effects found in this study.

On top of the systematic new data collection effort described above, I employ other descriptive data from various issues of the Federal Reserve Bulletin (Federal Reserve Board, 1920a)[25], the National Bureau of Economic Research (NBER) Macrohistory Database[26] and the U.S. Agricultural Census (1910 and 1920) as provided by Haines et al. (2016). Finally, I draw on a large range of qualitative information from contemporary sources such as annual reports, board meetings minutes and mimeos of the Federal Reserve Board (1920c,d,e,f,g,h,i,j, 1921, 1922)[27] and the final report of the Joint Commission of Agricultural Enquiry (1922)[28]. My discussion of experiment validity in the next section is furthermore informed by Governors' conference proceedings in 1920 later published by the Federal Reserve Board (1923). Several other archival sources such as speeches and testimonials before U.S. Congress are duly referenced throughout the paper.

[25]The source is freely accessible on-line in scanned format (FRASER, Federal Reserve Bulletin; last accessed 14 July 2020).
[26]The source is freely accessible on-line (NBER, Macrohistory Database; last accessed 14 July 2020).
[27]The source is freely accessible on-line in scanned format (FRASER, Annual Reports of the Federal Reserve Board; last accessed 14 July 2020).
[28]The source is freely accessible on-line in scanned format (HathiTrust, Final Report of the Joint Commission of Agricultural Enquiry; last accessed 14 July 2020).

3 Experiment validity and identification strategy

The specific historical context of the early 1920s in the United States constitutes a natural experiment which allows me to estimate the comparative causal effects of LAW and macroprudential policy. My research strategy exploits four unique features of this historical setting: effective variation in the policy response of Federal Reserve Banks to the post-World War I boom, the local continuity of baseline covariates including the absence of pre-trends in key dependent variables, the uniform regulatory framework of one constituent part of the U.S. banking sector and regional financial segmentation.

3.1 Variation in policy responses to the post-World War I boom

The policy measures at the core of this paper were taken in response to a pronounced boom phase which characterized the American economy after World War I. The strong economic expansion following armistice took the form of a commodity price boom, a subsequent rise in asset and real estate prices and rapid credit growth. In their classic study, Friedman and Schwartz (1963, p.222) describe the immediate post-war context as an "intense boom, marked by rapid accumulation of inventories and commodity speculation" and a "speculative climate, characterized by a strong demand for bank loans – which itself, of course, partly reflected the effect of prior monetary expansion". The nature and consequences of the extraordinary economic upswing attracted considerable attention in the economics and economic history literature. Recent contributions exploit the immediate post-war phase as an archetypal example to shed light on the anatomy of credit booms/crises (Rajan and Ramcharan, 2015, 2016) and stress its connection to bank failures during the 1920s (Jaremski and Wheelock, 2020a). Appendix A.1 provides more detail on the nature, extent and evolution of the post-World War I boom phase.

Monetary policy remained passive until January 1920, when discount rates were hiked from 4.75% to 6% uniformly across all Federal Reserve districts.[29] A second wave of policy decisions followed in late spring 1920. In contrast to January 1920, the decisions taken in late spring were not uniform across districts and resulted in those policy differences which are at the core of this paper (in Appendix A.5, I discuss the historical background of U.S. monetary policy decentralization before 1935 in more detail). Discount rates remained unchanged until 1 June 1920, but on or very shortly after this date four Federal Reserve Banks (Boston, Chicago, New York, and Minneapolis) hiked their policy rate to 7%. In the meantime, another four Federal Reserve Banks (Atlanta, Dallas, Kansas City and St Louis) had started a policy experiment by implementing the so called "progressive discount rate" (PDR), a new tool based on recently gained powers conferred by the Phelan Act of 13 April 1920. Congress had explicitly passed the Act to enable Federal Reserve Banks to establish graduated discount rates,

[29] This paper focuses on the Federal Reserve Banks' commercial paper rate which was the main interest rate for central bank discounts of all bills maturing within 90 days, secured by collateral other than government securities. In 1920, this class of bills constituted approximately between 30% and 50% of the System's discount holdings at the end of each month and between 15% and 50% of the total amount discounted each month (Federal Reserve Board, 1921). The share of commercial paper in the System's discount portfolio was continuously on the rise after mid-1919. Hence, Federal Reserve Bank directors considered the commercial paper rate as the most relevant rate at the peak of the boom (Federal Reserve Board, 1923, p.16).

and it had done so upon a recommendation of the Federal Reserve Board published in the System's annual report for 1919 (Wallace, 1956, p.61). The PDR scheme left the baseline discount rate unchanged at 6% but entailed progressive rate increases for member banks that were borrowing from Federal Reserve Banks at a level above their so called "basic line". The basic line represented the maximum amount of credit a member bank was entitled to receive from its Federal Reserve Bank. It reflected the amount of credit a given member bank would be able to obtain *pro rata* if all member banks in a district were to borrow simultaneously, without the Federal Reserve Bank having to violate its own reserve requirements.[30] The basic line of each member bank was computed on the basis of the bank's reserves maintained with and its capital contribution[31] to the Federal Reserve Bank:

$$BL = 2.5[0.65R + 0.03(C + S)][32]$$

where BL stands for the basic line,

R represents lawful reserves held with the Federal Reserve System,

C is the bank's paid-up capital and S its surplus.

The PDR penalized borrowing from the System in excess of the basic line: for every 25% by which a bank's borrowing exceeded the basic line, the bank had to pay a surcharge of 50 basis points. Hence, a bank with a basic line of \$100 intending to borrow \$200 from its Federal Reserve Bank would pay 6% for the first \$100 borrowed, and then 6.5%, 7%, 7.5% and 8% for each \$25 increment respectively, up to the full sum of \$200 (an average rate of 6.625%). Thus, the impact of the PDR on banks' borrowing costs depended on the individual leverage of each bank. The link between bank leverage and borrowing costs ran through the costs of required reserves for deposit liabilities. Due to deposit creation, a bank's deposit liabilities increased one to one with the loan portfolio. The more loans a bank granted, the more leveraged it became (i.e. the higher the ratio of total assets to capital) and the more of its basic line it had to use to fulfill reserve requirements.[33] Since it directly connected the marginal cost of reserves to the individual situation of a given bank, the progressive discount rate followed a rationale closely resonating with modern macroprudential policy tools. Similar to countercyclical buffers or reserve requirements, the scheme became particularly binding during the build-up phase of systemic risk: when financial institutions leveraged up in a boom phase, the PDR acted as a correcting force by dampening the incentives of financial institutions to grant additional loans and by forcing banks to internalize (at least) part of the potential systemic risk externalities generated by excessive credit expansion.[34]

[30] The Federal Reserve Banks had to hold gold reserves to cover note issuance and deposit liabilities. These gold reserve requirements must not be confused with the member banks' reserve requirements for their deposit liabilities. For more details on the Federal Reserve System's own gold reserve requirements, see Appendix A.2.

[31] When the Federal Reserve System was established in 1913, commercial banks which wanted to become members of the System had to contribute a share of their own capital to build the equity of the Federal Reserve Bank in their district.

[32] The exact rationale for this formula is explained in the report of the Joint Commission of Agricultural Enquiry (1922, p.24-25): 65% of R equals the member bank's reserve deposit minus the reserve which the Federal Reserve Bank is required to hold against this deposit. 3% of $C + S$ is the amount each member bank had to contribute to the Federal Reserve Bank's capital. Finally, the factor of 2.5 derives from the Federal Reserve Bank's 40% gold reserve requirement.

[33] For more details on the "reserve channel", c.f. Sections 1 and 5.

[34] "Excessive" credit growth is difficult to define objectively. What counts is that authorities at the time considered the build up to be "excessive", posing a threat to financial stability.

Table 1: Federal Reserve Bank policies pursued in late spring 1920

District	Policy rate set to 7%	PDR implemented	Policy discontinued*
District 1 Boston	4 June 1920	-	15 April 1921
District 2 New York	1 June 1920	-	16 June 1921
District 3 Philadelphia	-	-	-
District 4 Cleveland	-	-	-
District 5 Richmond	-	-	-
District 6 Atlanta	1 November 1920†	31 May 1920	6 May 1921
District 7 Chicago	1 June 1920	-	30 July 1921
District 8 St Louis	-	26 May 1920	23 June 1921
District 9 Minneapolis	1 June 1920	-	5 October 1921
District 10 Kansas City	-	19 April 1920	1 August 1921
District 11 Dallas	15 February 1921†	21 May 1920	25 June 1921
District 12 San Francisco	-	-	-

* Date when policy rate was reduced to 6% or PDR was abolished.
Source: Federal Reserve Board (1921, 1922); Wallace (1956)

† Districts 6 and 11 replaced the PDR with a rate hike to 7% (i.e. the LAW policy) in fall 1920 and spring 1921 respectively. I discuss the potential implications of this policy change when presenting my econometric results (c.f. Section 4).

Table 1 summarizes the exact dates on which the second wave of policies was implemented in the various districts and also shows their respective end dates. The four districts hitherto unmentioned (Philadelphia, Cleveland, Richmond and San Francisco) neither changed the rate schedule adopted in January 1920, nor did they implement the progressive discount rate.

In order to establish this historical setting as a convincing case study for the effects of financial stability policies, I provide a detailed discussion of experiment validity in Appendix A.2. Two questions stand out in this regard. First, was the Federal Reserve Banks' policy reaction in late spring 1920 effectively motivated by financial stability concerns? Second, what exactly were the financial developments the Federal Reserve Banks wished to counteract? In Appendix A.2, I show that the policy decisions taken in late spring 1920 were by no means simple, quasi-automatic consequences of the standard monetary policy rules at the time. Neither gold reserve requirements, nor any variant of the so called "real bills doctrine" can fully account for the introduction of LAW and PDR. The key to understanding the motivations driving Federal Reserve policy is to disaggregate, both geographically and over time. While the uniform rate hike in January 1920 is most convincingly explained by the gold reserve position of the System, the renewed policy action in late spring was motivated primarily by financial stability concerns. As documented by the Joint Commission of Agricultural Enquiry (1922, p.51-52),

Federal Reserve Banks which adopted financial stability policies aimed at "the preservation of the integrity of the banking system and the prevention of a financial panic". The authorities' thinking was that too accommodative a policy in their districts would induce banks to continue to expand loans at a time when commodity prices had started to fall, putting strain on their solvency if debtors' ability to repay loans were to dwindle (Joint Commission of Agricultural Enquiry, 1922, p.88). The Joint Commission of Agricultural Enquiry (1922, p.87) explicitly mentioned the gradual erosion of safety buffers for depositors as major concern for the Federal Reserve Banks which implemented financial stability policies.

The PDR enacted by the Federal Reserve Bank of Atlanta, St Louis, Kansas City and Dallas also targeted financial stability concerns but responded to the particular conditions prevailing in these districts. In contrast to Reserve Banks which subsequently opted for a rate hike, PDR districts observed large differences in the situation of individual member banks. "Some banks were greatly extended and borrowing heavily at the Federal Reserve Bank, in some instances as high as 10 or 15 times the basic line. Some banks were only slightly extended, borrowing moderately from the Federal Reserve Bank. Other banks were not extended at all, and were not borrowing from the Federal Reserve Bank in any amount" (Joint Commission of Agricultural Enquiry, 1922, p.53). Appendix A.2 reveals that districts which later adopted the PDR had indeed experienced the most skewed distribution of bank-level leverage and deposits-to-capital ratios prior to June 1920. Hence, the rationale for adopting the macroprudential tool of progressive rates was to distribute Federal Reserve Bank credit more evenly among the member banks in the PDR districts (Goldenweiser, 1925, p.42). The PDR did not penalize borrowing in general but only borrowing in excess of the basic line. Given the direct link between bank loans and reserve requirements, borrowing in excess of the basic line represented the very definition of what Federal Reserve Banks considered to be an "excessive credit expansion". The PDR constituted a targeted macroprudential tool used by some Federal Reserve Banks to dampen excessive credit growth fueled by some subgroups of member banks only.

3.2 Local continuity, pre-trends and uniform regulatory framework

Estimated treatment effects can be an artifact of spurious correlations, if baseline covariates and/or pre-trends were significantly different for treated and control group banks in my sample. Given that the policy variation across districts was motivated by differences in aggregate financial sector developments across Federal Reserve districts, the assumption of covariate balance is most likely violated when the full district data are considered. Thus, this paper "goes local" to tackle the endogeneity of policy reactions and to disentangle the supply-side response to financial stability policies from demand-side factors. I focus on small geographic bandwidths of 25 kilometers around Federal Reserve district borders. Within this distance of the district borders, banking structure, local economic characteristics and pre-trends were largely statistically identical for treated and control group banks.

Table 2 summarizes the continuity tests for variables describing the local banking structure in Panel A. Panel B checks for local continuity in economic characteristics. I obtain the coefficients and standard errors displayed in Table 2 by running a simple cross-sectional regression of the variable of interest on the treatment dummy. I run this regression separately for each border type, comparing bank- and county-level covariates of treated regions to their control group peers. Full sample tests based on my bank-level data clearly reject the continuity assumption for both border types in the case of banking sector characteristics. Banks subsequently treated by LAW were on average larger and exhibited significantly higher average leverage as well as deposit to capital ratios prior to June 1920 than banks located in districts which did not change policy stance. In contrast, the average bank in PDR districts was smaller, less leveraged and had a lower deposits-to-capital ratio than its control group peer prior to June 1920. The full sample continuity tests therefore confirm the endogeneity of policy decisions, as described in Appendix A.2. The tests suggest that "going local" is a crucial element of my identification strategy: virtually all differences in Panel A disappear for both border types once one concentrates on bandwidths of 25 kilometers around the borders. Some minor differences in the number and location of bank-level correspondent links remain. Given that interbank connections were highly "sticky" (at least for short time horizons), the bank fixed effects in my regressions directly control for the number and nature of banks' correspondent links.

Turning to local economic characteristics, the most pressing concern relates to the impact of the sharp recession of 1920-21. The post-World War I boom ended abruptly in the third quarter of 1920. According to the National Bureau of Economic Research (NBER), the business cycle peaked in January 1920. In fall 1920, the U.S. economy slid into a severe recession reaching a trough in July 1921 (Friedman and Schwartz, 1963). Commodity price collapses constituted one of the most important triggers for the sharp deterioration of economic conditions in late 1920. European agriculture had recovered much more quickly than expected from the devastation caused by World War I and started to displace American exports on world markets. Product prices imploded during the summer of 1920, putting those farmers under severe pressure who had indebted themselves to heavily expand production capacities during the boom phase (Rajan and Ramcharan, 2015; Jaremski and Wheelock, 2020a). If treated and control groups were affected differentially during the fall of 1920 due to their different exposure to the dramatic agricultural price declines, the estimated treatment effect could be subject to confounding factors stemming from this shock.[35]

"Going local" is one solution to control as much as possible for the differential exposure to confounding price shocks. Local economic characteristics likely determined the relative strength of the 1920-21 recession in different locations across the United States. Concerns about confounding bias might be unfounded if locations close to the district border exhibited similar structural economic features irrespective of treatment status. Panel B in Table 2 shows that a range of local economic characteristics related to agriculture and the commodity/land price boom (as reported by the U.S. Agricultural Census of 1920) are not statistically different in treated and

[35] Depending on the characteristics of treated and control regions, the bias in the treatment effect could be both upwards (amplifying the estimated coefficient) or downwards (muting the effect).

Table 2: Local continuity tests for banking and local economic structure

Panel A. Local banking structure

	LAW borders		PDR borders	
	Full sample	<25km	Full Sample	<25km
Total assets (ln, Sep 1919)	0.15	-0.18	-0.20	0.23
	(0.05)***	(0.12)	(0.06)***	(0.17)
Leverage ratio† (Jan 1920)	1.12	0.04	-0.51	0.57
	(0.15)***	(0.32)	(0.15)***	(0.55)
Deposits to equity ratio† (Jan 1920)	1.21	0.09	-0.37	1.15
	(0.15)***	(0.34)	(0.19)**	(0.79)
Cash reserves & exchange to deposits ratio†† (Jan 1920)	-0.01	0.01	0.05	-0.00
	(0.01)	(0.02)	(0.01)***	(0.03)
Total number of correspondents (Jan 1920)	-0.10	-0.13	0.02	0.13
	(0.06)	(0.15)	(0.08)	(0.25)
Total number of correspondents per 100K loans (Jan 1920)	-0.06	0.14	0.19	-0.24
	(0.03)*	(0.12)	(0.05)***	(0.14)*
Correspondent in New York City (dummy, Jan 1920)	0.05	0.06	-0.05	-0.15
	(0.01)***	(0.03)*	(0.02)**	(0.11)
Observations (number of banks)	2,621	261	1,287	65

Panel B. Local economic characteristics (all variables measured year-end 1919)

	LAW borders		PDR borders	
	Full sample	<25km	Full Sample	<25km
Total population (ln)	0.05	-0.25	-0.29	-0.08
	(0.20)	(0.23)	(0.10)***	(0.16)
Number of farms per inhabitant	0.00	0.01	0.03	0.00
	(0.01)	(0.01)	(0.01)***	(0.01)
Number of farms per acre	-0.01	-0.00	0.00	0.00
	(0.00)***	(0.00)	(0.00)**	(0.00)
Improved farm land per acre	-0.01	-0.00	-0.04	0.01
	(0.03)	(0.05)	(0.02)*	(0.06)
Average farm value	4,969.56	797.31	-3,936.00	-1,160.91
	(1,812.29)***	(1,099.54)	(475.81)***	(1,256.09)
Average share of farms mortgaged	0.10	0.04	-0.01	0.00
	(0.01)***	(0.02)*	(0.01)	(0.02)
Average debt to value ratio	0.56	0.52	2.40	1.21
	(1.30)	(1.23)	(0.61)***	(1.56)
Average mortgage interest rate	-0.18	-0.04	0.74	0.15
	(0.19)	(0.08)	(0.08)***	(0.15)
Exposure to traded crops†††	-0.03	-0.08	0.02	-0.03
	(0.02)	(0.06)	(0.02)	(0.04)
Observations (number of counties)	515	60	542	43

Coefficients obtained by simple regression on treatment dummy. Robust standard errors in parentheses.
County-level data weighted by number of banks in county.
*** p<0.01, ** p<0.05, * p<0.1

†In this paper, the leverage ratio is defined as the ratio of total lending to equity. Since the Rand McNally bankers directory (1920, 1921a,b) does not report total balance sheet size, I use total lending as the denominator for all call dates instead. Equity is defined throughout as the sum of total paid-up capital, surplus and undivided profits.

††Cash reserves include cash in vaults, reserves deposited with other banks and lawful reserves. Deposits constitute the total amount of deposits received, i.e. time and demand deposits.

†††Exposure to traded crops: this variable measures the share of barley, corn, cotton, oats, rye, tobacco and wheat acreage as a percentage of total county area. During the recession, all of these crops experienced heavy price declines of between 50% and 75% relative to their January 1920 values, c.f. NBER Macrohistory Database (Feenberg and Miron, 1995) and Appendix A.1.

control group areas. Stark differences in average farm values and mortgage debt exposure are observable in the full sample, but wash out once I focus on the area within 25 kilometers of the district borders. Moreover, to make sure that aggregate time trends (e.g. the sharp downturn starting in 1920) do not spuriously drive my estimation results, I also include time fixed effects in all my specifications. Finally, absence of level differences prior to the policy decision in late spring 1920 does not rule out the possibility of diverging pre-trends in local banking characteristics. In Table 3, I display the coefficients and standard errors obtained from a panel OLS regression of bank-level variables on a standard difference-in-differences treatment-time interaction. Controlling for time and bank fixed effects, Table 3 confirms that my main outcome variables and other bank-level characteristics exhibit no remaining, locally diverging pre-trends.

Table 3: Pre-trends in local banking characteristics (Sep 1919 - Jan 1920)*

	LAW borders		**PDR borders**	
	Full sample	<25km	Full Sample	<25km
Total lending (ln)	0.01	0.03	-0.04	0.00
	(0.01)	(0.03)	(0.02)**	(0.05)
Leverage ratio (ln)	0.01	0.02	-0.04	-0.01
	(0.01)	(0.02)	(0.02)**	(0.05)
Deposits to equity ratio (ln)	-0.02	0.02	0.04	0.03
	(0.01)**	(0.03)	(0.02)*	(0.08)
Cash reserves & exchange to deposits ratio	0.00	-0.00	0.08	-0.02
	(0.02)	(0.01)	(0.04)**	(0.02)
Total deposits (ln)	-0.02	0.02	0.04	0.05
	(0.01)*	(0.03)	(0.02)*	(0.08)
Bank equity (ln)	0.00	0.01	-0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Observations (number of banks)	5,217	517	2,567	129

Robust standard errors in parentheses.
County-level data weighted by number of banks in county.
*** p<0.01, ** p<0.05, * p<0.1

*I estimate the following model to check for pre-trends: $Y_{i,t} = \alpha + \beta Jan1920_t \times T_i + \phi_b + Jan1920_t + u_{i,t}$, where T_i indicates treated banks (treated either by LAW or by the PDR), ϕ_b captures bank fixed effects, and $Jan1920$ is a dummy flagging observations from January 1920. $Y_{i,t}$ are the variables tested for the presence of pre-trends and β represents the coefficient of interest displayed in Table 3. For the exact definitions of the variables, c.f. Table 2.

While observable variables show statistically identical pre-treatment levels and pre-trends within bands of 25 kilometers around the policy borders, less evident or not easily measurable discontinuities in financial/economic policies could represent an additional source of concern for identification. In this paper, I thus focus on so called "national banks" to preempt potential discontinuities in banking regulation and supervision. By 1920, national banks constituted a homogeneous class of Federal Reserve member banks with consistently enforced reserve requirements. National banks were subject to the same supervisory architecture and operated according to a uniform regulatory framework across all states. Furthermore, national banks never joined any of the state-sponsored deposit insurance schemes put in place after the panic of 1907 (Calomiris, 1989).[36] Due to this uniform regulatory framework, national banks represent an ideal study and control group. I provide more historical details regarding the U.S banking and regulatory landscape in 1920 in the Appendix A.3.

Despite the absence of policy discontinuities in national banking regulation at the federal level, differences

[36] After 1907, Oklahoma, Kansas, Texas, Nebraska, North Dakota, South Dakota, Mississippi, and Washington introduced deposit insurance open to state-chartered banks. Deposit insurance introduces further differences between state-chartered banks which cause cross-state (and intra-state) comparisons of these banks to become even less feasible.

in other economic, legal or political interventions might thwart identification whenever state borders coincide with Federal Reserve district borders. To ensure that estimated treatment effects are not driven by other discontinuities across these "double" borders, I exploit an additional quasi-experimental feature of my setting in the robustness checks of this paper. To isolate the impact of LAW and macroprudential policy from other policy differences, I focus exclusively on states whose territories were split between Federal Reserve districts with different policy responses to the financial stability concerns in 1920. The availability of split states also harbors a complementary advantage. It allows me to include state-chartered banks[37] into my discontinuity regressions because, at the state-level, the regulatory continuity precondition holds for these banks too. The inclusion of state-chartered banks enables me to check whether and how non-member banks in treated districts reacted to the policy changes and to what extent the impact in their balance sheets differed from the one experienced by Federal Reserve member banks.

One final continuity assumption of this paper is that – apart from the variation in policy responses in late spring 1920 – the Federal Reserve Banks implemented homogeneous lending policies across all the districts. In this regard, the presence of differential moral suasion strategies to "talk down credit" in 1920-21 could constitute a challenge for my identification strategy. Moral suasion, also known as "direct action", describes attempts by Federal Reserve Banks to prevent further loan expansion by formally or informally communicating their opinion on acceptable levels of credit growth to banks in their district. Systematic qualitative, let alone quantitative information on the importance of these challenges is scarce. For the period of interest, I could only identify one relevant bank credit-related circular by the Federal Reserve Bank of St Louis (dated 22 July 1920). Rather than focusing on the quantity of credit, however, the circular merely admonished banks for passing on higher policy rate to their customers.[38] A second concern is the potentially different application of collateral eligibility rules, loan to value ratios and/or haircuts across Federal Reserve Banks.[39] The little available anecdotal evidence shows that individual Federal Reserve Banks sometimes adjusted these lending conditions on the spot, to account for particular borrower characteristics.[40] Their tailored on-the-spot approach suggests that Federal Reserve Banks did not consistently or systematically differ in their application of these risk management techniques. Overall, the available information corroborates the premise that neither of these two concerns fundamentally undermines my empirical strategy. I discuss moral suasion and its potential implications in more detail in Appendix A.4.

3.3 Financial segmentation

While "going local" is necessary to address the endogeneity of policy reactions and to disentangle the credit supply response, this strategy may also come at a price. In modern day settings, banks situated close to policy

[37] In Appendix A.3, I contrast national banks with state-chartered banks. State-chartered banks were regulated according to different laws from state to state and cannot be easily compared to each other across state.

[38] The circular can be read here: FRASER, Circular Federal Reserve Bank of St Louis; last accessed 22 July 2020.

[39] I would like to thank David Wheelock for making me aware of this caveat. See also Tallman and White (2020) for this point.

[40] I am grateful to Mark Carlson for sharing this information with me, which is based on archival material from his ongoing project on Federal Reserve thinking on emergency liquidity provision in the years prior to the Great Depression.

borders would seem to be particularly prone to engage in regulatory arbitrage via relocation, branching or cross-border borrowing. The unique historical setting of my paper, however, largely rules out these possibilities to circumvent treatment and alleviates concerns that cross-border inter-bank borrowing results in SUTVA violations.

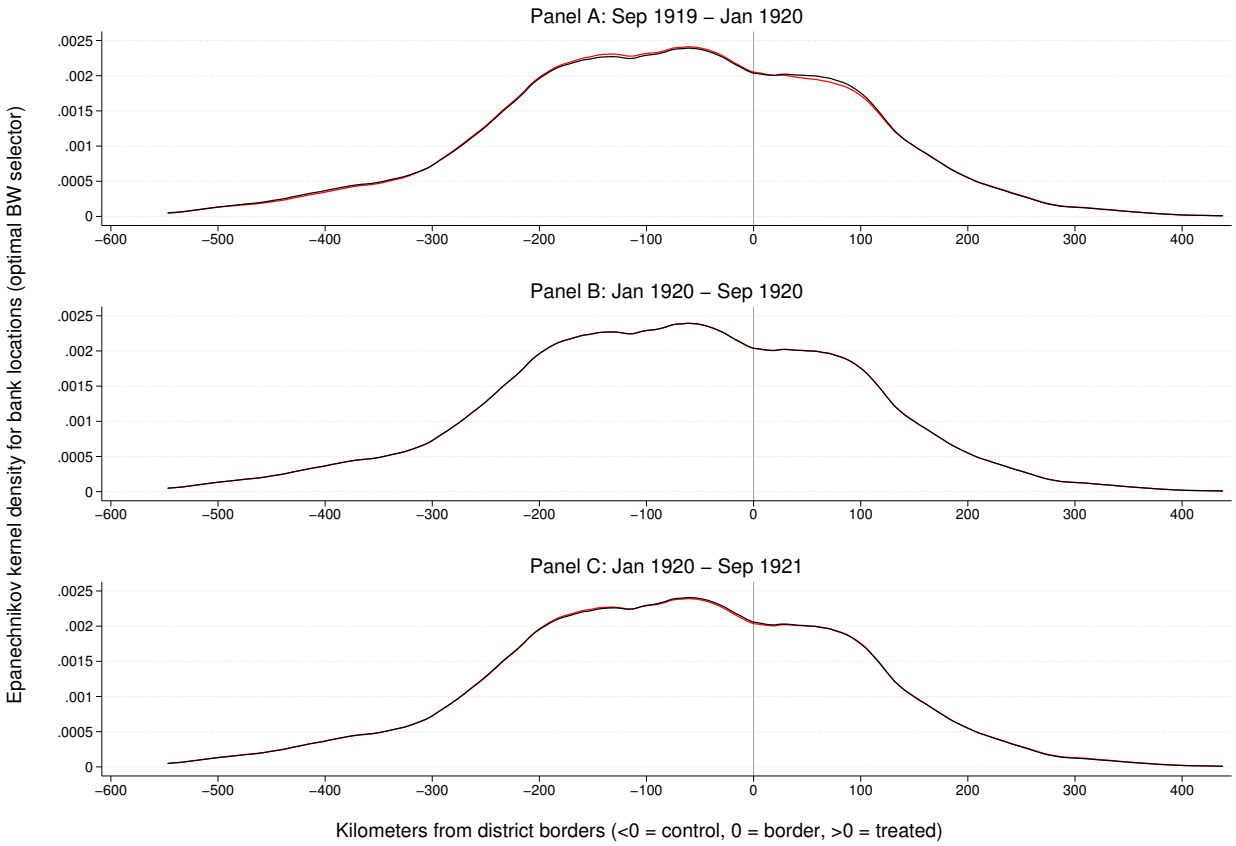
First, I show that banks in my sample did not relocate in anticipation, nor in reaction to policy differences. Figures 5 and 6 graphically compare the geographic distribution of national banks with respect to the nearest district border at three points in time. Figure 5 looks at borders separating districts which hiked rates to 7% and districts which did not enact policy changes. Figure 6 in turn looks at borders shared by PDR districts and no policy districts. In both figures, Panel A compares the distribution around the border in September 1919 to the distribution in January 1920, Panel B contrasts the situation in January 1920 to the one prevailing in September 1920 and Panel C displays the distributions in January 1920 and September 1921. Both figures testify to the fact that changes in the geographic distribution of banks with respect to district borders are practically nonexistent during the time periods considered in this paper. In Appendix A.6, I formally confirm these insights using statistical distribution and density tests. These results correspond to intuition. Given the costs and time involved in relocation, it is unlikely that national banks could or even wished to switch districts simply in order to avoid treatment. Moreover, the relatively short time window during which the LAW and the PDR scheme were in place probably preempted any relocation attempts which may have resulted from longer lasting policy differences.

Second, national banks were not authorized to engage in inter-state branch banking (Mitchener, 2005; Richardson and Troost, 2009). Before 1922, even intra-state branching was prohibited for national banks. Since the National Bank Act had not provided any explicit directives on the regulation of interstate banking, the Comptroller of the Currency issued the decisive direction in this regard (Johnson and Rice, 2007). After 1865, the OCC explicitly forbade national banks to open an office in more than one location. Consequently, the national banking sector was characterized by a true unit banking structure.

Third, member banks located in a given Federal Reserve district could only borrow from the Federal Reserve Bank heading their district. Direct borrowing from a Federal Reserve Bank in another district was ruled out from the beginning by the organization of the Federal Reserve System (Hackley, 1973). For example, a national bank located in the Federal Reserve district of Boston was not allowed to apply for loans from the Federal Reserve Bank of New York. This form of financial segmentation thus regulated access to central bank lending facilities in a way which made direct regulatory arbitrage impossible. Banks subject to different monetary policies could not directly avoid treatment by cross-district borrowing from another Reserve Bank.

Fourth, whether member banks circumvented monetary policy decisions by borrowing from their correspondent banks in other districts remains an open question. The available empirical evidence on the 1920s shows that differentials in Federal Reserve Bank discount rates did not trigger corresponding flows of funds between districts (Cohen-Setton, 2016). This finding would suggest that interbank markets were not used to engage

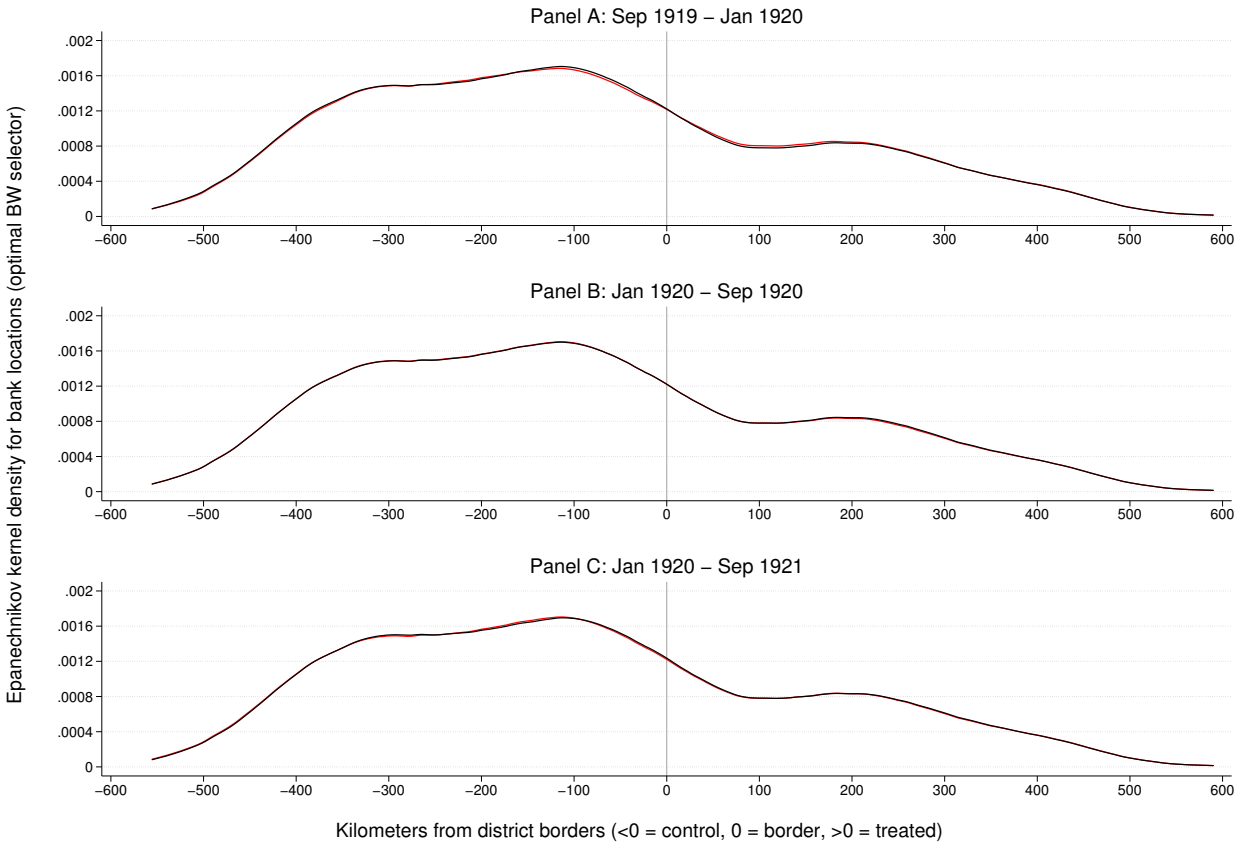
Figure 5: Kernel densities for national bank locations around LAW* borders (red line represents earlier date in each panel)



Source: Annual Report of the Comptroller of the Currency (1919–1921) and Rand McNally bankers directory (Jan 1920); own calculations

*LAW borders constitute Federal Reserve district borders separating districts which hiked the policy rate to 7% and districts which did not change policy stance in late spring 1920. In my sample, these district borders are the borders separating 1) district 4 (Cleveland) and district 7 (Chicago); 2) district 2 (New York) and district 3 (Philadelphia); 3) district 2 (New York) and district 4 (Cleveland).

Figure 6: Kernel densities for national banks locations around PDR borders* (red line represents earlier date in each panel)



Source: Annual Report of the Comptroller of the Currency (1919–1921) and Rand McNally bankers directory (Jan 1920); own calculations

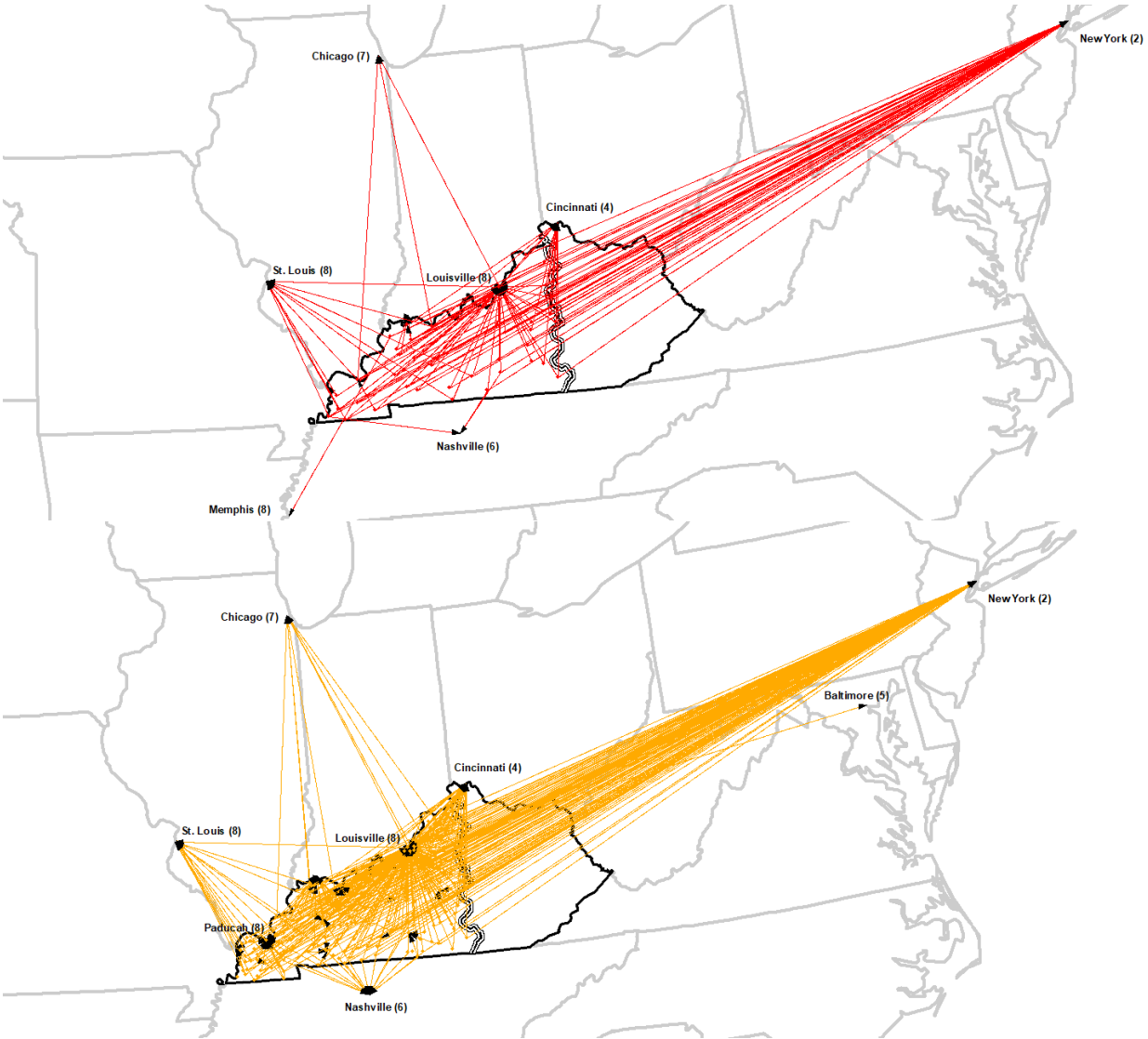
*PDR borders constitute Federal Reserve district borders separating districts which introduced the PDR and districts which did not change policy stance in late spring 1920. In my sample, these district borders are the borders separating 1) district 4 (Cleveland) and district 8 (St Louis); 2) district 4 (New Cleveland) and district 6 (Atlanta); 3) district 5 (Richmond) and district 6 (Atlanta).

in policy arbitrage. The fact that Federal Reserve Banks maintained different policy rates throughout the 1920s suggests that the districts were at least partly financially segmented – otherwise, policy differences could have simply not been meaningfully maintained inside the U.S. monetary union. At the same time, historical anecdotes on the use of correspondent networks to bypass "unpleasant" monetary policy decisions point into another direction.[41] Since limitations in the data for inter-district flows of funds between member banks do not allow for an encompassing study[42], the available empirical evidence should be interpreted with caution. In the context of my study, arbitrage via correspondent banks stacks the deck against finding significant treatment effects because it biases treatment coefficients for LAW and macroprudential policies downwards.

Finally, even if banks exploited their interbank network to circumvent financial stability policies, violations of the no interference component of SUTVA are unlikely to result from this form of regulatory arbitrage. Due to the pyramid structure of the U.S. banking system, most of my sample banks' out-of-district correspondents were located in central reserve cities or reserve cities. Therefore, the nature of the interbank network mostly ruled out direct correspondent lending from banks just across the district border. Given that my treatment and control groups are located in close bands around the district borders, arbitrage via correspondent banking is unlikely to breach the no interference assumption in my estimation samples. Second, the very design of Federal Reserve district borders captured major regional correspondent networks within a single district (Jaremski and Wheelock, 2017). Hence, by construction, correspondent links between less important banking locations had a high probability of being "fenced" into one common Federal Reserve district. First-hand evidence on the premise that cross-border interbank links do not violate SUTVA is depicted in Figures 7 and 8. The figures focus on the case of split states because banks in these states appear least immune to SUTVA violations due to interbank borrowing: located within the same state but in different Federal Reserve districts, these banks seem most likely to have interbank ties that cut through district borders. Figures 7 and 8 show clearly that treated (non)member-banks in Kentucky and New Jersey maintain virtually no interbank links with their peers in the the untreated half of the state. Hence, even my arguably most demanding specification is unlikely to fall prey to SUTVA violations that could otherwise bias treatment coefficients upwards. I provide more details on the U.S. interbank market structure (including figures depicting the links of banks located in the non-treated half of split states) and on the design of Federal Reserve districts in Appendix A.5.

[41] For an example relevant to the specific context of this study, c.f. Meltzer (2003, p.107).
[42] Inter-district flow of funds for member banks are only available for major (central) reserve cities, c.f. Cohen-Setton (2016).

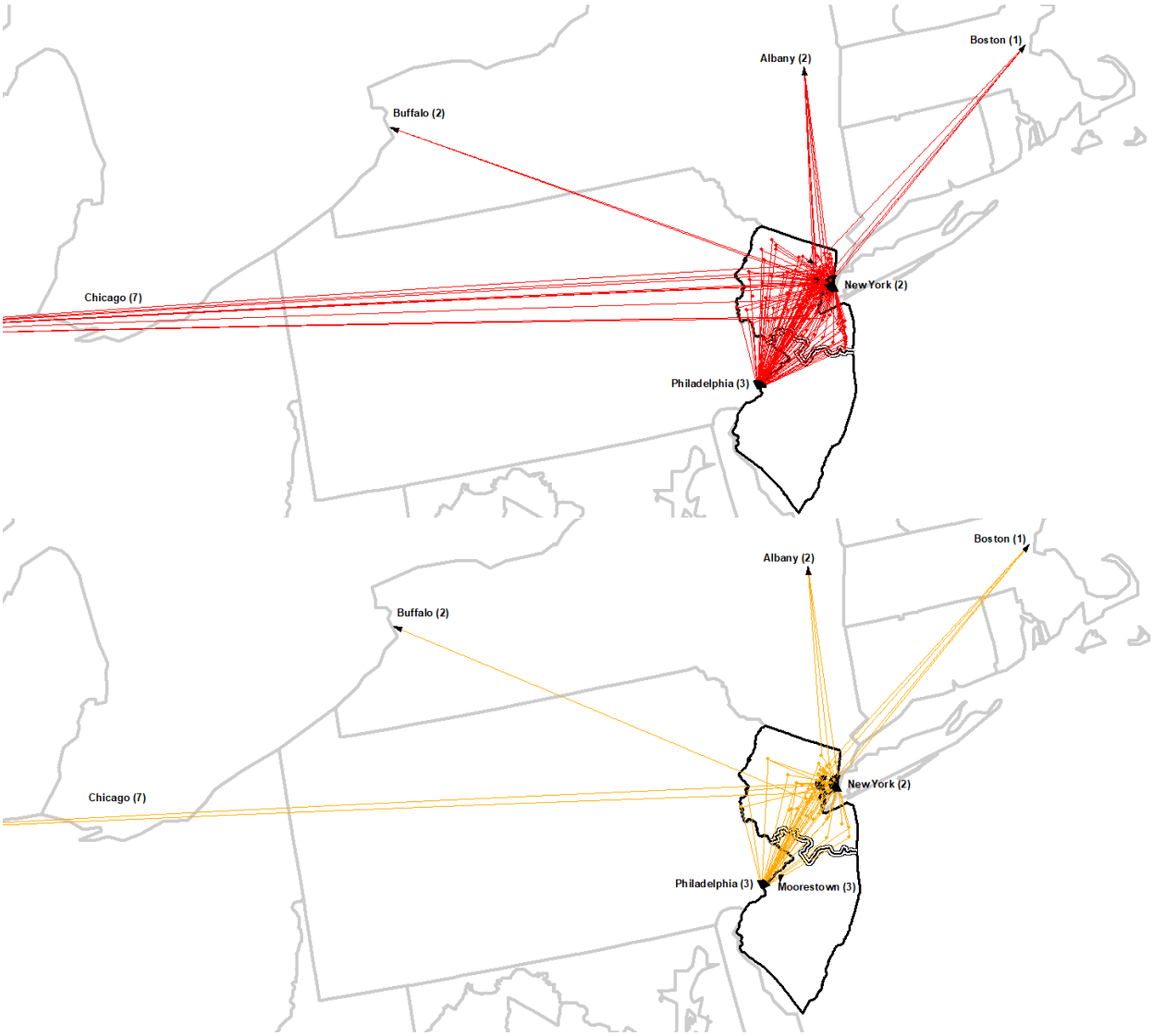
Figure 7: Interbank links of banks in the split state of Kentucky (district 8)



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

* This graph plots the interbank links of all commercial banks located in the treated half in the split state of Kentucky. The upper panel shows the outgoing correspondent links of Federal Reserve member banks (red lines). The lower panel shows the outgoing correspondent links of non-member banks (orange lines). The names of the most important correspondent cities are indicated on the map (including the number of the district in which the city is located).

Figure 8: Interbank links of banks in the split state of New Jersey (district 2)



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

* This graph plots the interbank links of all commercial banks located in the treated half in the split state of New Jersey. The upper panel shows the outgoing correspondent links of Federal Reserve member banks (red lines). The lower panel shows the outgoing correspondent links of non-member banks (orange lines). The names of the most important correspondent cities are indicated on the map (including the number of the district in which the city is located).

4 Results

4.1 Policy effects on bank lending and leverage

Drawing on the identification strategy explained above, I estimate the causal effects of financial stability policies using a local difference-in-difference design:

$$Y_{i,t} = \delta(T_i \times Post_t) + \mathbf{\Psi}'\mathbf{X}_{i,t} + \phi_b + \gamma_t + u_{i,t} \tag{1}$$

where $Y_{i,t}$ is the bank-level outcome variable; T represents an indicator taking the value of one if a given bank i is located in a district which implemented LAW or macroprudential policy (and zero otherwise); $Post_t$ is a dummy flagging observations from the treatment period (i.e. call dates after late May/early June 1920); $\mathbf{X}_i$ stands for bank-level controls; ϕ_b are bank-level fixed effects absorbing all time-invariant bank-specific differences in the outcome variables; γ_t represents time fixed effects capturing call date-specific aggregate time trends and u_i is the bank-specific error term.

The main parameter of interest in Model 1 is δ, the effect of LAW or macroprudential policy on bank-level outcomes $Y_{i,t}$. To estimate the policy-specific δ, I run two separate series of regressions. The first series exploits the policy variation across the borders between the Federal Reserve districts which implemented LAW and the Federal Reserve Banks which did not change policy stance in late spring 1920. In this case, δ represents the treatment effect of conventional monetary policy leaning against the wind. The second series of regressions exploits policy differences across borders separating districts subject to the macroprudential policy and districts which did not change policy stance in late spring 1920. In this second case, δ measures the treatment effect of macroprudential policy. I estimate both series of regressions using the full sample and gradually smaller bandwidths (of 200, 100, 75, 50 and 25 kilometers) around the district borders. For example, the bandwidth of 25 kilometers means that all national banks located within 25 kilometers on either side of the border are included in the estimation sample.

Monetary policy can affect bank balance sheets by triggering changes in quantities as well as in (asset) prices (IMF, 2015). Disaggregated bank-level information on asset composition at market prices is not available for the 1920s. Consequently, I focus on bank-level changes in balance sheet quantities and ratios as my main outcome variables of interest ($Y_{i,t}$). In particular, I estimate the effect of LAW and macroprudential policy on banks' total lending and the bank-level leverage ratio. As discussed in Appendix A.2, these two variables constituted the focal point of Federal Reserve officials' discussions in spring 1920. The Federal Reserve Banks motivated policy action with reference to what they deemed excessive upward trends in these variables. To facilitate the interpretation of the estimated treatment coefficient, I transform both outcome variables by taking their the natural logarithm.

The regressions using total lending as the main outcome variable include a time-varying control variable for bank-level liquidity (cash reserves & exchange to deposits ratio). When drawing on the second outcome variable which represents a ratio (leverage, i.e. the ratio of total lending to equity), I also control for changes in bank-level equity over time, in addition to liquidity. These control variables are represented by $\mathbf{X}_i$. I do not control for covariates capturing changes in deposits because these variables vary one for one with banks' lending activity in contexts where loans involve deposit creation. Appendix B.1 shows summary statistics for all the variables included in Model 1.

Table 4: Treatment effects for LAW and PDR policy (including all border regions for LAW and PDR policy)

Panel A. Leaning against the wind

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.00	0.02	0.03	0.04	0.06	0.05
	(0.01)	(0.01)**	(0.01)***	(0.01)***	(0.01)***	(0.02)***
	[0.01]	[0.01]**	[0.01]***	[0.01]***	[0.02]***	[0.02]**
R-squared	0.22	0.23	0.33	0.33	0.39	0.45
Observations	10,589	8,018	4,560	3,534	2,169	1,047

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.00	0.01	0.02	0.03	0.07	0.06
	(0.01)	(0.01)	(0.01)**	(0.01)***	(0.01)***	(0.02)***
	[0.01]	[0.01]	[0.01]*	[0.01]**	[0.02]***	[0.02]***
R-squared	0.23	0.25	0.34	0.34	0.43	0.44
Observations	10,589	8,018	4,560	3,534	2,169	1,047

Panel B. Progressive discount rate

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.06	-0.04	-0.06	-0.04	-0.05	-0.10
	(0.01)***	(0.02)***	(0.02)***	(0.02)*	(0.03)**	(0.05)**
	[0.01]***	[0.02]**	[0.02]**	[0.03]	[0.03]	[0.06]
R-squared	0.18	0.23	0.35	0.37	0.35	0.39
Observations	5,191	2,535	1,272	923	662	262

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.06	-0.04	-0.06	-0.04	-0.06	-0.11
	(0.01)***	(0.02)***	(0.02)***	(0.02)*	(0.03)**	(0.05)**
	[0.01]***	[0.02]**	[0.02]***	[0.03]	[0.03]*	[0.06]*
R-squared	0.27	0.34	0.43	0.46	0.38	0.46
Observations	5,191	2,535	1,272	923	662	262

Standard errors in parentheses. Clustered standard errors (at bank-level) in squared brackets.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

Table 4 summarizes the baseline results for both policy types and outcome variables. The coefficients are estimated on the basis of all LAW and PDR border regions. For LAW, all banks located at the border separating district 4 and district 7, as well as banks located at the border separating district 2 from district 3 or 4 are included in the estimation sample. To estimate the policy effect of the PDR, I draw on all banks in my sample located at the border between district 8 and district 4, as well as all banks at the border between district 6 and district 4 or 5. Panel A displays the treatment effects of LAW on bank-level lending and leverage. The

corresponding treatment effects of the progressive discount rate are shown in Panel B. The full sample results in the leftmost column of Table 4 suggest that the LAW policy did not have an economically, nor a statistically significant impact on bank-level outcomes. The PDR, however, reduced total lending and leverage by around 6%. For the full sample, the PDR treatment effects are statistically different from zero at the 99% confidence level. As one approaches the border, the dampening impact of the PDR on bank credit is less precisely estimated, but tends to become even more pronounced (10% to 11% for the 25km radius). The PDR thus emerges as an effective macroprudential tool in reining in banks' credit growth at the time. In contrast, the local discontinuity regressions for LAW show that the interest rate hike exerted a perverse influence on bank credit. Focusing on the sample of banks located within 25km of the district borders, LAW appears to have caused total lending and leverage to increase by between 5% to 6% (statistically significant at the 99% confidence level).

I provide several additional results related to Table 4. Appendix B.2 reports coefficients and standard errors for the control variables (bank-level liquidity and equity) alongside the policy treatment effects. Appendix B.3 provides econometric evidence that the results reported in Table 4 continue to hold – and are even strengthened in the case of the PDR – when I compute Conley (1999) standard errors to correct for spatial auto-correlation, instead of conventional and clustered standard errors. Finally, in Appendix B.4, I explore an alternative cross-sectional geographic regression discontinuity (RDD) specification (local linear regression). While the size and sign of coefficients I obtain are similar to the results of the local difference-in-differences estimator, the treatment effects are less stable and less precisely estimated with the geographic RDD approach. Since the cross-sectional RDD specification does not allow me to control for bank-level fixed effects, it may not sufficiently capture unobserved heterogeneity at the bank-level. As a corollary, the risk of residual omitted variable bias is higher in the cross-sectional RDD set-up than in the local difference-in-differences model. Thus, the latter constitutes my preferred specification.

In order to check for heterogeneity in the treatment effects, I first split the LAW sample into a Western border (district 4 vs. district 7) and an Eastern border (district 2 vs. districts 3 and 4) estimation sample. The results for the Western and Eastern border are displayed in Panel A and B of Table 5. The results in Table 5 reveal that aggregate treatment effects for LAW mask substantial geographic heterogeneity. While the interest rate hike did reduce credit growth in the Midwest, the downward pressure exerted by LAW on banks' credit expansion was both economically and statistically weak relative to the PDR's effects. In particular, Panel A in Table 5 demonstrates that the policy impact vanishes as one approaches the border. In the New York district, however, the LAW policy triggered a strong perverse impact (see Panel B in Table 5) which drives the aggregate results for LAW displayed in Table 4. The treatment effect identified off the closest bandwidth around the border (25km) amounts to an 8% to 9% increase in bank lending and leverage in response to the interest rate increase. I analyze the underlying reasons for the considerable geographic heterogeneity in the treatment effects of LAW in Section 5 below.

In Table 6, I investigate potential differences in treatment effects for PDR districts. While the Southern

Table 5: Treatment effects for LAW: Western vs. Eastern borders

Panel A. Western LAW border (district 4 vs. district 7)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.07	-0.03	-0.03	-0.03	-0.02	-0.01
	(0.01)***	(0.01)**	(0.01)**	(0.02)*	(0.02)	(0.03)
	[0.01]***	[0.01]**	[0.02]*	[0.02]	[0.02]	[0.04]
R-squared	0.19	0.18	0.44	0.48	0.40	0.39
Observations	5,569	3,336	1,375	1,005	648	312

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.04	-0.02	-0.03	-0.02	-0.01	-0.00
	(0.01)***	(0.01)*	(0.01)**	(0.02)	(0.02)	(0.03)
	[0.01]***	[0.01]*	[0.02]*	[0.02]	[0.02]	[0.04]
R-squared	0.22	0.24	0.52	0.56	0.57	0.54
Observations	5,569	3,336	1,375	1,005	648	312

Panel B. Eastern LAW border (district 2 vs. districts 3 and 4)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02	0.04	0.06	0.06	0.09	0.08
	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.02)***
	[0.01]**	[0.01]***	[0.01]***	[0.02]***	[0.02]***	[0.02]***
R-squared	0.23	0.24	0.32	0.31	0.40	0.45
Observations	9,512	7,104	4,125	3,209	1,964	935

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02	0.03	0.04	0.04	0.09	0.09
	(0.01)**	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.02)***
	[0.01]**	[0.01]***	[0.01]***	[0.01]***	[0.02]***	[0.03]***
R-squared	0.23	0.25	0.32	0.31	0.43	0.45
Observations	9,512	7,104	4,125	3,209	1,964	935

Standard errors in parentheses. Clustered standard errors (at bank-level) in squared brackets.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Treatment effects for PDR: Northern vs. Southern borders

Panel A. PDR borders (without district 6)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.08	-0.05	-0.12	-0.11	-0.12	-0.14
	(0.02)***	(0.03)**	(0.03)***	(0.04)***	(0.04)***	(0.07)**
	[0.02]***	[0.02]**	[0.03]***	[0.03]***	[0.04]***	[0.06]**
R-squared	0.19	0.23	0.34	0.36	0.35	0.42
Observations	4,085	1,972	968	679	469	175

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.06	-0.03	-0.09	-0.08	-0.09	-0.11
	(0.02)***	(0.02)	(0.03)***	(0.04)**	(0.04)**	(0.07)*
	[0.02]***	[0.02]	[0.03]***	[0.03]**	[0.04]**	[0.07]*
R-squared	0.25	0.32	0.40	0.44	0.32	0.38
Observations	4,085	1,972	968	679	469	175

Panel B. PDR border (without district 8)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.05	-0.04	-0.03	-0.02	-0.02	-0.08
	(0.01)***	(0.02)**	(0.03)	(0.03)	(0.03)	(0.06)
	[0.02]***	[0.02]*	[0.03]	[0.03]	[0.04]	[0.07]
R-squared	0.19	0.23	0.36	0.37	0.35	0.40
Observations	4,641	2,260	1,107	830	570	210

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.05	-0.05	-0.05	-0.03	-0.04	-0.10
	(0.01)***	(0.02)***	(0.02)*	(0.03)	(0.03)	(0.06)*
	[0.02]***	[0.02]**	[0.03]*	[0.03]	[0.04]	[0.07]
R-squared	0.27	0.34	0.44	0.46	0.39	0.47
Observations	4,641	2,260	1,107	830	570	210

Standard errors in parentheses. Clustered standard errors (at bank-level) in squared brackets.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

regions and districts included in the PDR borders sample are arguably more homogeneous than the Western and Eastern LAW border samples, one important caveat may apply to the aggregate results displayed in Table 4. As shown in Section 3 (c.f. Table 1), district 6 adopted the PDR only for the period between 31 May and 1 November 1920, after which date the Federal Reserve Bank of Atlanta switched to the LAW policy. Since parts of my PDR border sample draw on treated banks in district 6, I re-estimate the PDR treatment effects excluding the Atlanta district. For completeness, I also re-estimate the impact of PDR without the banks located in district 8. The findings in Table 6 are consistent with the estimated treatment effects of LAW. The exclusion of the mixed policy district Atlanta leads to even larger and more precisely estimated PDR effects, which now entail a reduction in total lending and leverage of up to 14% relative to control group banks (Panel A of Table 6). When concentrating on the Atlanta district (Panel B), the PDR treatment coefficients converge to the effects of LAW on the Western border and also vanish when one approaches the border line. These results thus confirm that the PDR was more effective than LAW in taming credit growth.

4.2 Robustness checks

I pursue five different strategies to test the robustness of the treatment effects induced by LAW and the PDR. First, I conduct a pre-treatment Placebo test. The financial stability policies were introduced in late spring 1920. Hence, total lending and leverage of treated banks in LAW and PDR districts should not have evolved differently from control group banks due to treatment before these dates. I test this hypothesis by checking for pre-treatment effects between September 1919 and January 1920. Having already checked for pre-trends in Section 3 (c.f. Table 3), I replicate this test for the different radius cut-offs (full sample, 200, 100, 75, 50 and 25km) and include the standard control variables from Model 1. I report the results for the pre-treatment Placebo test in Appendix C.1. I find no evidence for pre-trends suggesting that pre-existing trends do not spuriously drive my estimation results.

In my second Placebo test, I replicate the local difference-in-differences regressions above drawing on fictitious policy discontinuities between districts which did not change policy stance in late spring 1920. As shown in Figures 1 and 2, Districts 3, 4 and 5 did not change policy stance and simply kept the prevailing policy rate at 6%. Hence, I test for the presence of treatment effects where there should be none by exploiting three combinations of fictitious policy discontinuities between these districts. For each of the three combinations, I "pretend" that banks in one of the districts were treated by a financial stability policy, while I assume that financial institutions in the other two districts were not. I report the results for this Placebo test in Appendix C.2. I find no evidence for a local treatment effect for any of the fictitious policy discontinuities.

Third, I replicate the local difference-in-differences regressions drawing exclusively on bank-level data from two federal states which were split by Federal Reserve district borders with different policies: New Jersey and Kentucky. New Jersey's territory is split between district 2 (LAW) and district 3 (no policy). Kentucky is split

between district 8 (PDR) and district 4 (no policy). The split state regressions address the worry that differential (economic) policies at the state-level could bias my estimated treatment effects because such differences may induce a spurious discontinuity in outcome variables across state borders. One reason for this concern is that the estimated treatment coefficients for LAW and the PDR tend to increase in size as one approaches the border (c.f. Tables 4 to 6). Hence, to make sure that my results are not driven by discontinuities across state borders unrelated to LAW and the PDR, I apply Model 1 to split state data only. I report the results for this robustness check in Appendix C.3. I find no evidence for an upward bias in the treatment effects resulting from the LAW policy. In fact, the split state specification for New Jersey results in even larger (perverse) treatment effects. For the PDR policy, my split state results suggest a small upward bias (i.e. a more negative coefficient) relative to the results obtained when excluding the Atlanta district (c.f. Table 6, where the reported impact amounts to between -11% and -14%). Overall, however, the local treatment effects for PDR remain stable, pointing to a reduction in total lending and leverage by around 10%.

Fourth, I implement a Placebo test to check for post-treatment effects. Total lending and leverage of treated banks in LAW and PDR districts should not have evolved differently from control group banks due to treatment after the two policies were discontinued. I can test this hypothesis based on split state data because I collected national bank balance sheets for the July 1921 call date for the federal states of New Jersey and Kentucky. In the two split states, the financial stability policies were discontinued on 16 June 1921 (district 2) and on 23 June 1921 (district 8) respectively. Thus, I replicate the local difference-in-differences regressions by drawing on data from the July and September 1921 call dates only. The results are summarized in Appendix C.4. I find no evidence for the presence of treatment effects after the financial stability policies were discontinued.

Finally, I estimate Placebo regressions exploiting balance sheet data from state-chartered banks. State-chartered banks located in treated territories, which did not become members of the Federal Reserve System (so called "non-member banks"), should have been less strongly affected by the financial stability policies because they did not directly interact with the Federal Reserve Bank in their districts. Non-member banks were not allowed to borrow from the Federal Reserve Banks. I implement the Placebo test using bank-level data from the split states of New Jersey and Kentucky. The split state specification is the cleanest way to test for policy effects on non-member banks because different states had different regulations for state-chartered financial institutions. The Placebo test results are reported in Appendix C.5. The coefficients suggest that the two policies had no measurable effect on non-member banks (the treatment effects are not statistically different from zero).

5 Mechanism

The econometric results give rise to two questions. First, why was the PDR more effective in dampening credit growth and leverage than LAW in district 7? Second, why did LAW trigger perverse treatment effects in district 2? The present section analyzes the mechanisms underlying these findings. To answer the first question, I proceed in three steps. First, I investigate the relative impact of LAW and PDR policies on banks' incentives to grant new loans. Second, I explore how funding shocks affected banks under the two different policy regimes and I provide narrative evidence on the interaction between these shocks and financial stability policies at the time. Third, I back up the insights from step 1 and 2 by reporting descriptive evidence on the distribution of banks' borrowing relative to the basic line in PDR districts. To address the second question, I concentrate on differences in usury laws along the Western and Eastern LAW borders and I show that these differences confronted banks with varying incentives to engage in regulatory arbitrage.

5.1 The reserves channel: incentives to grant new loans

In 1920-21, the transmission of monetary policy to bank balance sheets worked primarily through the so called "reserves channel" (Carlson and Duygan-Bump, 2018).[43] Banks' reserve requirements for demand and time deposits initiated regular direct interactions between the Federal Reserve System and its member banks. In order to address a deficient reserve position, member banks had to borrow from their Federal Reserve Bank at the prevailing policy rate. In normal times, a deficient reserve position resulted mainly from deposit creation which, in turn, was a consequence of granting new loans to bank customers. Since changes in the nominal policy rate i directly impacted the marginal cost of reserves, the reserves channel endowed Federal Reserve Banks with the ability to influence banks' incentives to grant new loans.

Both LAW and the progressive discount rate scheme increased the marginal cost of reserves. LAW translated into a flat increase in the marginal percentage cost of reserves irrespective of the amount a given bank was already borrowing from its Federal Reserve Bank. In contrast, the PDR turned the cost of borrowing from the Federal Reserve into a function of a bank's current level of borrowing from the Reserve Bank relative to its basic line. For modestly leveraged banks in PDR districts, the marginal cost of reserves could be well below the one faced by banks in LAW districts or even identical to the cost of reserves in districts which did not change policy stance in late spring 1920. Banks which had already been borrowing substantially above their basic line when the PDR was first introduced, however, faced much higher marginal costs than credit institutions located in LAW districts. As a corollary, the relative impact of LAW and the PDR on bank-level outcomes is not obvious *ex ante* and constitutes an empirical question: it depends on average basic line usage in PDR districts. In order to corroborate the statistically and economically significant effect of the PDR – without resorting to additional mechanisms at play –, some banks in the PDR districts must have been borrowing far more than their basic

[43] Other transmission channels of monetary policy signals rose to importance only later during the 1920s when the Federal Reserve System started to engage in open market operations (Bordo and Sinha, 2016).

line when the progressive discount rate scheme was introduced. Only in this case could initially over-leveraged banks have dragged down the mean value of bank-level outcome variables sufficiently to generate larger negative and more significant treatment effects than LAW.

Unfortunately, systematic bank-level data on the actual level of banks' borrowing from their Federal Reserve Bank are not available.[44] Hence, I resort to balance sheet simulations akin to a "stress-test" to illustrate the average impact of the two policies on treated banks under different scenarios of basic line usage. Rather than making assumptions about the entire distribution of banks' pre-treatment level of borrowing from the Federal Reserve Bank, I pursue a strategy of reverse engineering. I focus on how the marginal incentives of banks to expand their loan portfolio play out under different policy regimes. This approach allows me to pin down the average level of basic line usage necessary to make the PDR more binding than LAW. In subsection 3 below, I plausibilize these scenarios by exploiting the available descriptive evidence on member banks' aggregate basic line usage published in the final report of the Joint Commission of Agricultural Enquiry (1922).

To compute the mean marginal rate faced by banks in my sample, I proceed as follows. I start by calculating the individual basic lines of banks in my sample as of September 1919. I focus on balance sheet data from September 1919 for two different reasons. First, drawing on data recorded after treatment had begun (late spring 1920) would induce post-treatment bias in my calculations. Second, I use balance sheets from September 1919 rather than January 1920 because only the OCC reports feature dis-aggregated data that allows for the precise reconstruction of banks' individual basic lines. Furthermore, only the OCC balance sheets provide information on the amount of lawful reserves individual national banks maintained with their Federal Reserve Bank as well as data on the banks' cash held in vaults. These variables enable me to plausibilize assumptions I have to make for the simulation exercise (see next paragraph) and they allow for an extension of the simulation exercise to include funding shocks (see subsection 2 below).

I assume banks face the decision to grant a new loan of size x, where x is measured as a percentage of banks' currently outstanding loan portfolio. For the simulation exercise, I consider new loans sized between 5% and 90% of banks' actual loan portfolio in September 1919. The new loan constitutes the source of "stress" in my simulation exercise: each new loan makes it necessary for banks to borrow from the Federal Reserve System at interest rate i to fulfill the higher absolute reserve requirements. To calculate the cost i of additional reserves required following the granting of a new loan of size x, I assume that banks did not maintain excess reserves with their Federal Reserve Bank.[45] The interest rate i depends on the policy regime in place (LAW vs PDR). For LAW, i is always 7%. In the case of the PDR, i is a function of basic line usage and of the new loan's size. If the new loan is large enough, it may trigger an additional reserve requirement that causes a given bank's exposure vis-à-vis the Federal Reserve Bank to exceed its basic line or push it into the next cost bracket (e.g.

[44] The detailed national bank examiner reports provide data on current borrowing from the Federal Reserve System (including both discounts and advances). The examinations are conducted on different dates for each bank, however, and the snapshots they represent are therefore not easily comparable.

[45] A comparison of required reserves to lawful reserves actually maintained in September 1919 shows that national banks did not generally maintain excess reserves with the Federal Reserve Bank. This finding is intuitive because banks had a strong incentive to deposit excess reserves with their correspondents in larger cities where these deposits were remunerated.

from 100-124% basic line usage at a marginal i of 6.5%, to 125-149% basic line usage at an i of 7%). Having thus calculated i for different levels of basic line usage and for different sizes of new loans, I aggregate the bank-level results to compute the mean marginal rate faced by banks in my sample.

Figure 9: Mean marginal interest rate under LAW and macroprudential policy: the case of new loans

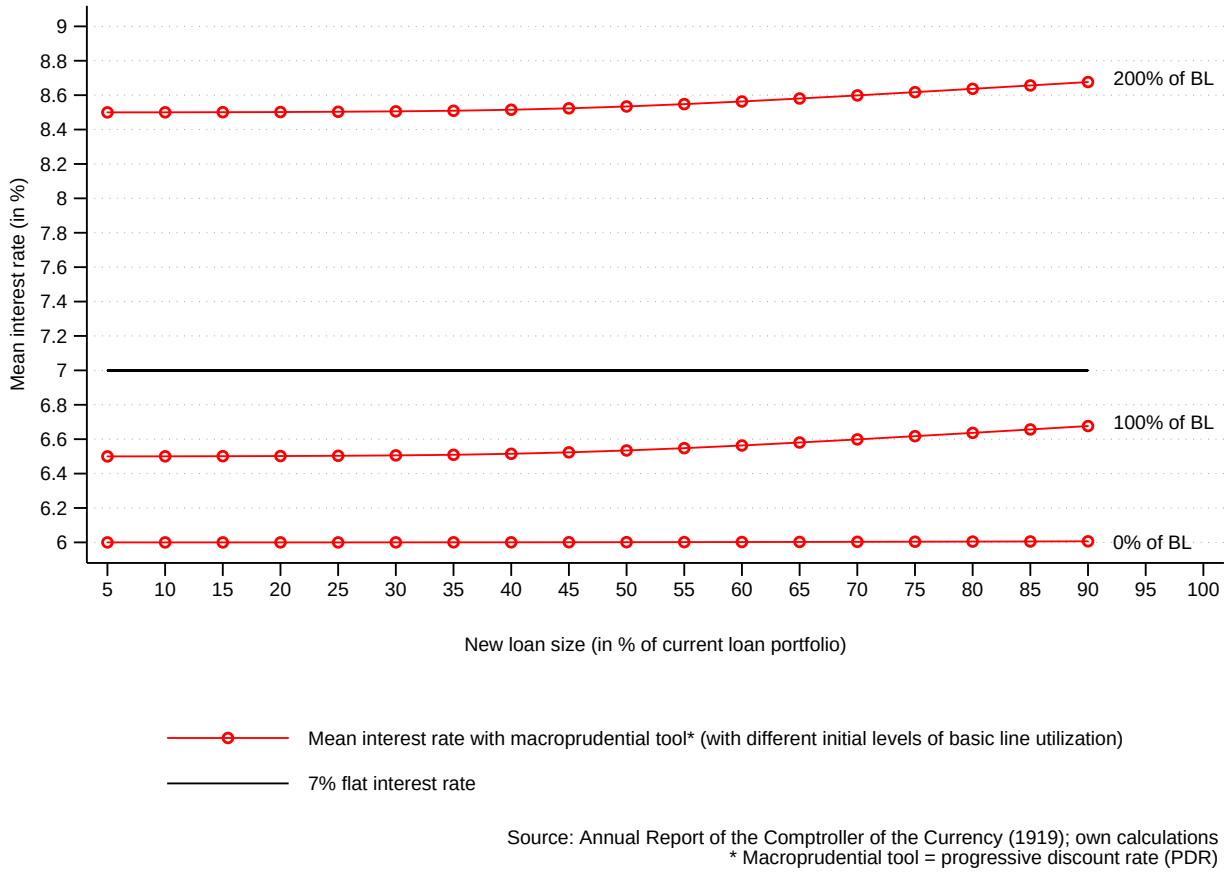


Figure 9 shows the mean marginal interest rate paid by banks in the sample for additional reserves required after granting a new loan. The graph shows the interest rate as a function of the size of the loan (x-axis) and banks' usage of the basic line (BL). The indicated interest rate is faced by the average bank in the sample when it grants a new loan of size x. In the case of LAW, the usage of the basic line does not affect marginal costs as the policy translates into a flat rate increase. The marginal cost of reserves in no-policy (i.e. 6% flat) districts corresponds to PDR costs under the scenario of 0% basic line usage.

Figure 9 shows the mean marginal rate for newly borrowed reserves faced by banks in my sample, as a function of loan size and for different scenarios of basic line usage. As Figure 9 illustrates, for a given size of new bank loans, higher basic line usage shifts the mean marginal interest rate schedule upwards. This relationship simply reflects the basic dynamics of the PDR: a basic line utilization of 100% prior to the new loan means that the bank borrows the additional required reserves at a minimum rate of 6.5%; a basic line utilization of 200% in turn will shift the minimum marginal rate up to 8.5%. In other words, as soon as the mean bank in the macroprudential policy districts utilizes more than 125% of its basic line, the average impact of PDR on the marginal cost of reserves will be at least equal to the impact of LAW (keeping all else equal).[46]

By definition, in Figure 9 the size of the new loan to be granted has no effect on the mean marginal interest rate in LAW districts. Even in PDR districts, however, loan size exercises but a small influence on the marginal

[46]The incentive for banks to grant new loans depends on the costs of required reserves relative to the expected future income generated by the new loan. The expected income in turn depends on the default probabilities of borrowers, other administrative costs and, of course, the interest rate charged by the bank. Since no bank-level data is available for any of the variables relevant for computing loan income, I approach the problem from the cost side while assuming the income side as fixed.

interest rate. A non-linear increase in mean marginal interest rates starts to appear only when the new loans become larger than 50% of the current portfolio for prior basic line usage of 100% and 200%, and even in these cases the impact on the mean marginal rate is negligible. Nonetheless, above the 50% threshold the loan alone is large enough to shift the bank into progressively higher rate schedules. In the case of 0% basic line usage prior to the new loan, large loan sizes never make the average bank transgress the 100% usage threshold and therefore the marginal interest rates never surpass the flat 6% rate.

5.2 Basic line dynamics and the marginal cost of reserves: the case of funding shocks

In his primer on the progressive discount rate, Wallace (1956) discusses an additional twist to the story of 1920-21. Wallace (1956) argues that deposit withdrawals from banks in treated districts may have substantially reinforced the treatment effect of the macroprudential tool. Although Wallace (1956, p.68) does not formally test his idea, his contribution connects the effect of the progressive discount rate directly to the roots of the recession in 1920-21:

> Farmers in agricultural districts being unable to sell their products for enough to liquidate bank loans, or in many cases to sell them at all, drew down their deposits to pay debts to merchants and factors and others who in turn paid wholesalers or manufacturers in the cities who in turn liquidated their bank loans. [I]n every such transaction an equivalent amount of reserves was transferred from the bank in the agricultural area to the bank in the non-agricultural area, [...] the full explanation of why basic lines fell so low in agricultural areas, thereby forcing the banks to borrow heavily at their Federal Reserve Bank. The difficulty of the banks lay not so much in a tremendous increase in deposits relative reserves as in a tremendous decrease in reserves relative to deposits. At the time an Alabama bank was forced to pay a [maximum marginal] rediscount rate of 87.5 per cent, its reserve balance had fallen to $86!

Wallace's (1956) argument proceeds in five steps. First, agricultural price declines during the crisis of 1920-21 forced farmers to withdraw deposits to redeem their debts. Second, in order pay out farmers, banks had to tap into their reserves stored with the Federal Reserve Bank because the cash in banks' vaults did not suffice. Third, banks had to borrow from the Federal Reserve Banks for two reasons: on the one hand, to replenish the reserve balance since the withdrawals forced banks' reserve balances below the required minimum; on the other hand, to obtain the liquidity necessary to honor deposit liabilities. Fourth, given that banks' reserve balances had fallen, their basic lines, which were directly coupled to the reserve balance (c.f. Section 3, subsection 1), decreased too. Fifth, for banks located in PDR districts the marginal cost of reserves increased (in part drastically) because basic lines had fallen to levels so low that even a small increase in borrowing from the Federal Reserve Bank led to a transgression of the basic line. One could add a final sixth element to this narrative in order to complete the story: the high costs incurred by some of the banks must have entailed a strong deterring effect to grant new loans given that the marginal cost of reserves was so elevated.[47]

[47] To be sure, the dynamics discussed by Wallace (1956) do not challenge my identification strategy. My estimation framework

The narrative in Wallace (1956) suggests an interesting additional transmission channel of the PDR policy: the impact of funding shocks. I illustrate the effect of funding withdrawals in a stress-testing exercise akin to the one presented in the previous subsection. I consider the case of a static, one-off funding shock that occurs at one specific moment in time.[48] For each bank, I compute a range of differently sized funding shocks as a percentage of its current demand deposits. The shock may take any size between 5% and 90% of current demand deposits. Furthermore, to obtain conservative simulation results, I assume that each bank's cash position as shown on the balance sheet is perfectly liquid.[49] Cash in vaults represents the first line of defense against funding shocks. Since I assume banks deplete their cash reserves before tapping into Federal Reserve System credit, I deduct the liquid reserves held from the amount to be borrowed following a funding shock. Thus, in my stress-test scenarios, borrowing from the Federal Reserve Bank only occurs once the bank has completely run out of cash reserves.[50]

Figure 10 shows the mean marginal interest rate faced by banks in PDR and LAW districts under different scenarios of funding withdrawal intensity and basic line utilization. When comparing Figure 10 to Figure 9 above, it becomes clear that funding shocks trigger much larger increases in the mean marginal interest rates in PDR districts than the different loan size scenarios discussed in the previous subsection. Even for the case of no pre-treatment borrowing from the Federal Reserve Bank (0% basic line usage), funding shocks can push the mean marginal rate above the 7% flat rate. For scenarios with pre-treatment basic line usage above 50%, already small to medium size funding shocks can make the macroprudential policy more binding than the flat LAW rate hike.

The stark differences between the case of new loans and the case of funding shocks come about because the amount borrowed from the Federal Reserve Bank is an order of magnitude higher in the context of the latter exercise. When granting a new loan, the bank in question only needs to borrow a fraction of the loan amount to fulfill higher reserve requirements. In contrast, when funding shocks hit a given bank and cash reserves are not sufficient to honor all withdrawal demands, the bank has to borrow the entire remainder (withdrawals minus cash in vaults minus excess reserves) from its Federal Reserve Bank. If the remainder is large or if the affected bank was already borrowing heavily from the Federal Reserve Bank prior to the shock, the PDR quickly pushed the member bank into higher marginal rate schedules. In Appendix D.1, I also report the underlying distributions of the maximum marginal rate at which the banks in my sample subject to the PDR were borrowing under three

is based on small bandwidths around the district borders where agricultural intensity, and therefore deposit withdrawals, were highly similar before treatment occurred in late spring 1920. My research design also preempts worries that withdrawals of reserves from agricultural regions and their subsequent transfer to non-agricultural regions could violate the no interference component of SUTVA. My local estimation strategy makes sure that control regions exhibited a degree of agricultural intensity highly similar to treated areas. Thus, even if inflows of reserves impacted banking in non-agricultural regions further away from the border, the locally randomized natural experiment I exploit in this paper is not affected by these shifts.

[48] Simulating the impact of a one-off shock of size x rather than the impact of consecutive small shocks that together amount to x provides for conservative lower-bound estimates of the effect of funding withdrawals. Consecutive small shocks would gradually reduce the basic line as both deposits and the required reserve balance fall. Consecutive small funding shocks thus trigger additional increases in the mean marginal interest rates paid for the liquidity needed by the bank to honor its deposit liabilities.

[49] This assumption stacks the cards against finding a strong impact of deposit withdrawals. It may be overly optimistic to consider banks' cash position as perfectly liquid because it also contains exchanges and cheques.

[50] Since this second stress-testing exercise again uses data from balance sheets recorded in September 1919, one further assumption is implicit in my approach. I assume that the cash reserve position on the call date in September 1919 is generally representative of banks' average cash reserve position and, in particular of the position in late spring 1920. Potential window-dressing on call dates and more extended loan portfolios in late spring 1920 could also stack the cards against finding large impacts of funding shocks.

Figure 10: Mean marginal interest rate paid on borrowing from the Federal Reserve System: the case of funding shocks

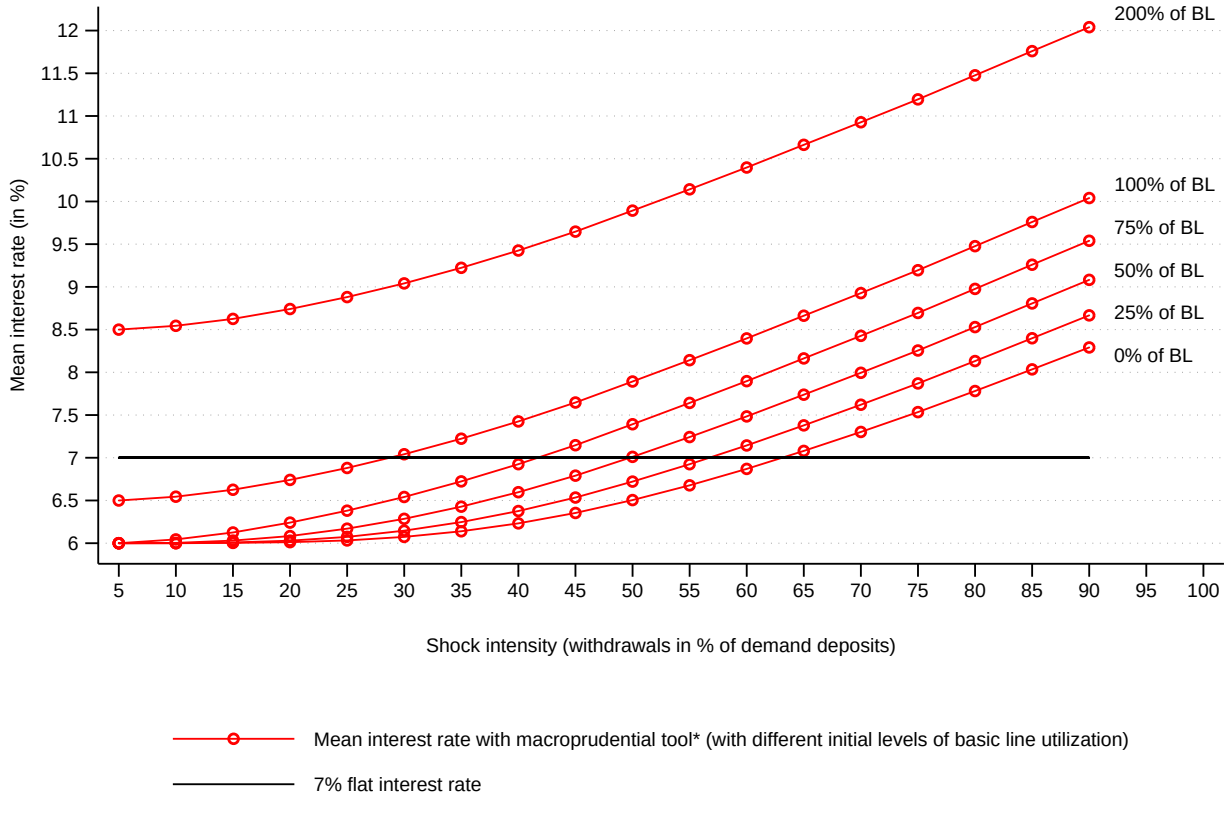


Figure 10 shows the mean marginal interest rate paid by banks in the sample on borrowing from the Federal Reserve Bank after being subject to a one-off funding shock. The graph shows the interest rate as a function of shock intensity (x-axis) and banks' usage of the basic line (BL). The indicated interest rate is faced by the average bank in the sample when it is subject to a funding shock of size x. In the case of LAW, the usage of the basic line does not affect marginal costs as the policy translates into a flat rate increase. The marginal cost of reserves in no-policy districts would correspond to a flat line at 6%. The mean marginal interest rate faced by banks in the PDR districts surpasses the interest rate costs of LAW at different thresholds of shock intensity, depending on the pre-treatment utilization of the basic line.

different scenarios of pre-treatment basic line utilization. In contrast to the mean marginal rate, the maximum marginal rate is the rate paid by a given bank on the last bit of borrowing. Depending on prior basic line usage and the size of the funding shock, the maximum marginal rate could quickly reach levels twice as high as the 7% LAW rate and, in extreme cases, also exceed 20%.

The present subsection shows that it was not necessary for basic line utilization to be unrealistically skewed in PDR districts, nor was it essential that basic lines were already fully exhausted when treatment was introduced. Funding shocks may have been an additional catalyst of the policy effect. The dynamics of the recession of 1920-21 may have endogenously reinforced the impact of macroprudential policy. Facing deposit withdrawals, banks had to borrow from the Federal Reserve System at interest rates which could have increased rapidly if the funding shock was large. Moreover, although I have only considered simple static shocks in this subsection, the fall in reserve balances stored with the Federal Reserve Bank subsequent to the decrease in bank deposits meant that basic lines were gradually diminished at a time when demand for Federal Reserve Bank loans increased. For some banks, these dynamics – or even merely the expected impact of these dynamics – may have drastically reduced the incentives to grant new loans.

5.3 Descriptive evidence on basic line usage

For a convincing explanation of the transmission channels and the strong treatment effect of macroprudential policy relative to LAW, the remaining challenge consists in plausibilizing scenarios which result in stronger impacts of the PDR scheme. The crucial question is whether the distributions of basic line utilization prior to and during the treatment period could result in average policy impacts significantly larger than those of LAW. Some of the most relevant information in this regard was collected and published by the Joint Commission of Agricultural Enquiry (1922). Qualitative evidence from its final report suggests that basic line utilization was indeed highly skewed just before the macroprudential policy was enacted. The report mentions that within the very same district, basic line utilization could range from 1500% (i.e. 15 times the basic line) to 0% (i.e. banks which did not borrow at all from their Federal Reserve Bank) (Joint Commission of Agricultural Enquiry, 1922, p.53). While the number of banks effectively paying high average rates following the start of the PDR scheme remained rather modest[51], Wallace (1956, p.61) emphasizes that the available data do not reflect "the extent to which banks avoided payment of progressive rates by reducing their own loan portfolios". The number of banks deliberately deleveraging in response to the policy or in anticipation of its effects may have been (much) higher than the number of banks effectively borrowing at elevated rates.

To further plausibilize the scenarios discussed in the previous subsections and to shed light on the accuracy of the narrative put forward by Wallace (1956), I exploit aggregate data on basic line utilization in the seven constituent states of the Tenth Federal Reserve district (Colorado, Kansas, Missouri Nebraska, New Mexico,

[51] Based on the congressional record, Wallace (1956, p.61) reports that 44 banks in the Atlanta district, 49 banks in the St Louis district, 114 bank in the Kansas City district and 20 banks in the Dallas districts paid average interest rates higher than 10%.

Oklahoma and Wyoming) as reported by the Federal Reserve Bank of Kansas City to the Joint Commission of Agricultural Enquiry (1922). The Federal Reserve district of Kansas City was the only district which published this type of information. The data cover each of the 16 months between April 1920 and July 1921. I discuss the origin of these data in Appendix D.2, where I also display the numbers in separate tables for each state. The tables in Appendix D.2 provide direct descriptive evidence compatible with the claim that the PDR scheme generated an incentive structure prone to trigger stronger credit restraint than LAW. Average basic line usage in three of the states (Missouri, Nebraska and New Mexico) exceeded the threshold of 125% – which I identified in the first subsection above – several times during the period under observation. According to the stress-testing exercise, the marginal mean costs of granting new loans during these months was therefore higher than it would have been had the tenth district implemented a rate hike to 7%.

The true underlying distribution of basic line utilization, however, was likely more skewed than conveyed by the aggregate numbers in Appendix D.2. Additional descriptive data from the report of the Joint Commission of Agricultural Enquiry (1922) shows that, although on average a third of all member banks was borrowing in excess of their basic line in district 10, 23 banks located in Omaha and Kansas City virtually monopolized borrowing from the Federal Reserve Bank by absorbing 73% of the Bank's lending power.[52] Eight months after the introduction of the PDR scheme, these banks' share had been reduced to 49% while the share of banks which did not borrow from the Federal Reserve Bank had decreased markedly from 61.7% to 33.8% (Wallace, 1956, p.63). Hence, the qualitative evidence available suggests that the constraints introduced by the PDR scheme were binding for highly leveraged banks and led to a redistribution of borrowing from the Federal Reserve.

Finally, Appendix D.2 also speaks to the narrative in Wallace (1956). The Tenth Federal Reserve district includes some of most agriculturally intensive regions of the United States (Haines et al., 2016). The evolution of lending by the Federal Reserve Bank in district 10 and the relative number of banks in each of the three categories (excessive borrowers, borrowers, non-borrowers) should thus reflect the course of the crisis of 1920-21 fairly well – both on aggregate and in the different states. In all seven states average basic line utilization indeed reached the highest levels during the peak of the crisis in the fourth quarter of 1920 and the first quarter of 1921. The fourth quarter of 1920 and the first quarter of 1921 cover most of the immediate post-harvest season.[53] Therefore, it seems plausible that losses of reserves constituted an important factor pushing banks up the ranks from borrowing below the basic line (or not borrowing at all) into the group of excessive borrowers. Aggregate data on percentage changes in the deposit liabilities of member banks seems to confirm this link as deposits in agricultural counties fell by more than twice as much as in non-agricultural counties at the time (11.1% relative to 4.4.%, c.f. Wallace (1956, p.67)).

[52] The lending power of the Federal Reserve Bank was computed on the basis of reserves and capital deposited by member banks with the Federal Reserve Bank. The idea of a specific amount of lending power was a theoretical concept which normally did not have direct policy relevance because Federal Reserve Banks could borrow from each other via the interdistrict settlement fund (Wallace, 1956; Tallman and White, 2020).

[53] Perhaps counter-intuitively, the data for individual states show basic lines for excessive borrowing reached their peak at the height of the crisis. This peak most likely resulted from the selection of banks into the excessive borrowing category rather than increases in the individual basic lines of banks.

5.4 Usury rates and the perverse effects of LAW

In order to shed light on the mechanism underlying the perverse treatment effects in district 2, I build on a seminal insight by Stiglitz and Weiss (1981): credit market imperfections which inhibit the adequate pricing of risk can induce quantity rationing. In Stiglitz and Weiss (1981), banks ration credit to customers at rate r^* (i.e. they grant no loans at rates higher than r^*) because expected profits decline at rates higher than r^* due to adverse selection. In the United States of the 1920s, state usury rates on local bank loans represented an additional credit friction, on top of potential imperfect information problems (Ryan, 1924). Akin to the dynamics in Stiglitz and Weiss (1981), binding usury rates may have caused the quantity of credit to remain capped due to the state usury rate u^s – despite the fact that demand for more loans at interest rates higher than u^s did exist.[54] In this situation, if $u^s < r^*$, lifting the usury ceiling can result in an increase in credit supply at a range of rates r, where $u^s < r \leq r^*$. In this subsection I show that the introduction of LAW policy in district 2 eased the credit friction induced by u^s and thus likely caused higher costs for borrowing from the Federal Reserve to go hand in hand with an increased quantity of bank lending.

I proceed in several steps to explain why the interest rate hike to 7% eased the usury rate ceiling and triggered an increase in total bank lending in district 2, but not in district 7. First, I show that u^s differed substantially from state to state.[55] Figure 11 depicts the state usury rates u^s prevailing in my sample of LAW borders. Whereas u^s amounted to 7% and 8% in the Western states (Michigan, Indiana, Ohio), the maximum rate national banks were allowed to charge on local loans along the Eastern LAW border (New Jersey, New York, Pennsylvania) was only 6%. In other words, only in the East did the rate hike to 7% cause the cost of borrowing from the Federal Reserve System to exceed the maximum interest rate national banks could charge on local loans – and it did so by a hefty margin of 100 basis points.

Figure 11: Usury rates for LAW borders in estimation sample

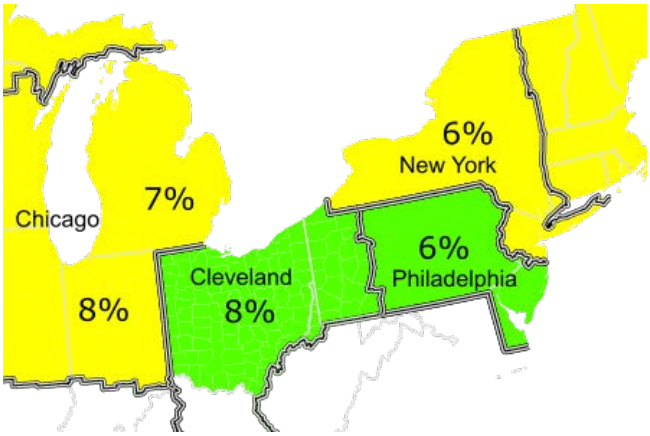


Figure 11 shows the maximum rates which banks were allowed to charge on local loans in the states included in my sample to estimate the treatment effect of LAW.

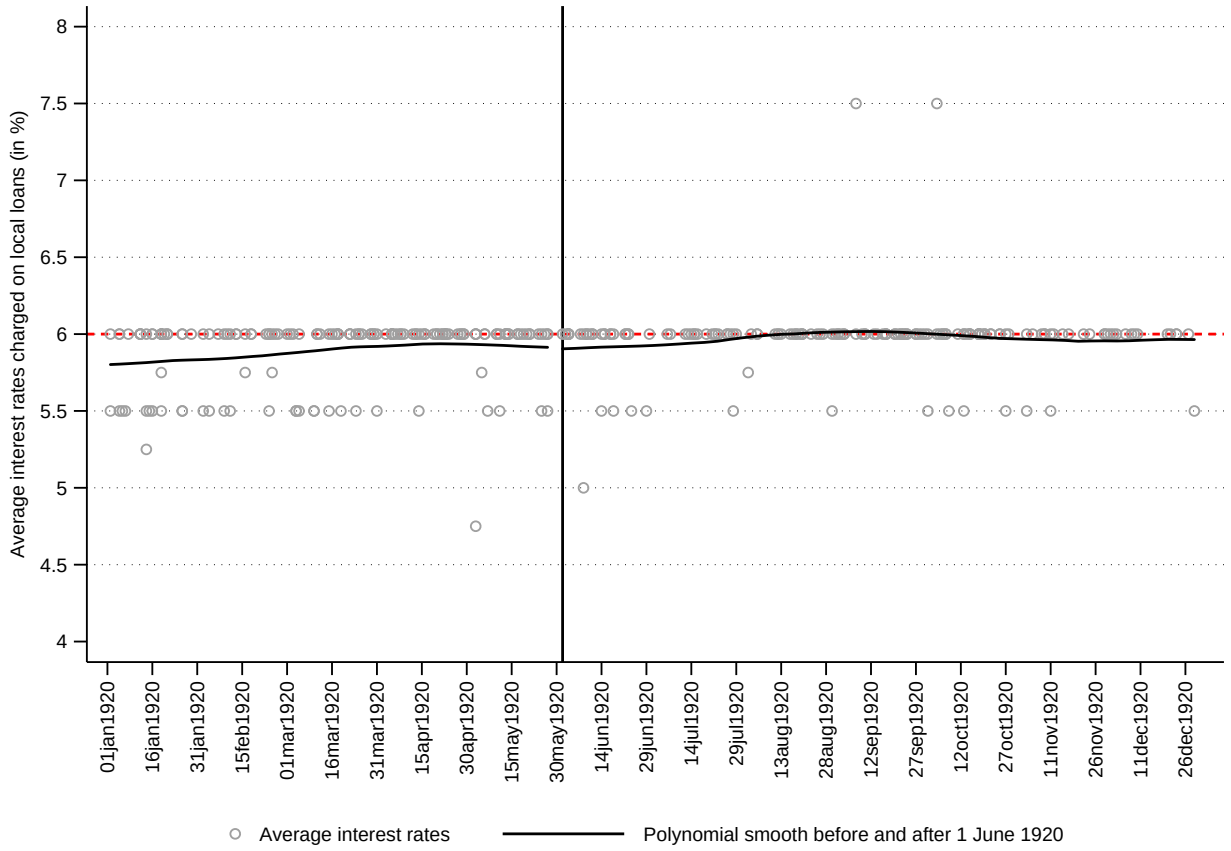
Second, I can show that, before 1 June 1920, u^s was a binding ceiling for local loans in the East, but not

[54] For example, Temin and Voth (2008) show that the introduction of usury rates in eighteenth century England worsened the access to credit for loan applicants with little social capital as they were rationed out of the market.

[55] The differences in state usury rates do not invalidate my research design which relies on a comparison of national banks with identical usury rates in small bandwidths around the district borders. See also Table 3 in Appendix A.2.

in the West. For this purpose I collect and compare bank-level data from Indiana (district 7) and New Jersey (district 2). I describe my data sources for the bank-level interest rates and bank-level loan decomposition used below in Appendix D.3. Figures 12 and 13 display the universe of interest rates on local loans charged by national banks in Indiana and New Jersey in 1920. The x-axis reflects the date of the examiner report corresponding to a given bank's interest rate. The horizontal dashed red lines represent the respective usury rate ceilings (6% for New Jersey national banks and 8% for national banks located in Indiana). Figure 12 illustrates that the usury rate ceiling was highly binding for local loans in New Jersey before and after 1 June 1920. On average, national banks charged 5.88% before 1 June 1920 and 5.97% in the months following 1 June 1920. In contrast to the distribution of rates prevailing in New Jersey, the data for Indiana banks in Figure 13 show that the usury rate ceiling of 8% was not binding for local interest rates before 1 June 1920. On average, national banks located in Indiana charged average interest rates slightly below 7% (6.78%) before 1 June 1920, and the banks only increased rates marginally to 7.14% after 1 June 1920. Hence, while u^s was not binding for national banks in Indiana, the banks in this state did already charge interest rates substantially above the level prevailing in New Jersey before the LAW policy was enacted. Granted the *ceteris paribus* assumption, this difference in rates could be interpreted as evidence for the presence of unsatisfied loan demand at higher, but illegal rates in New Jersey.

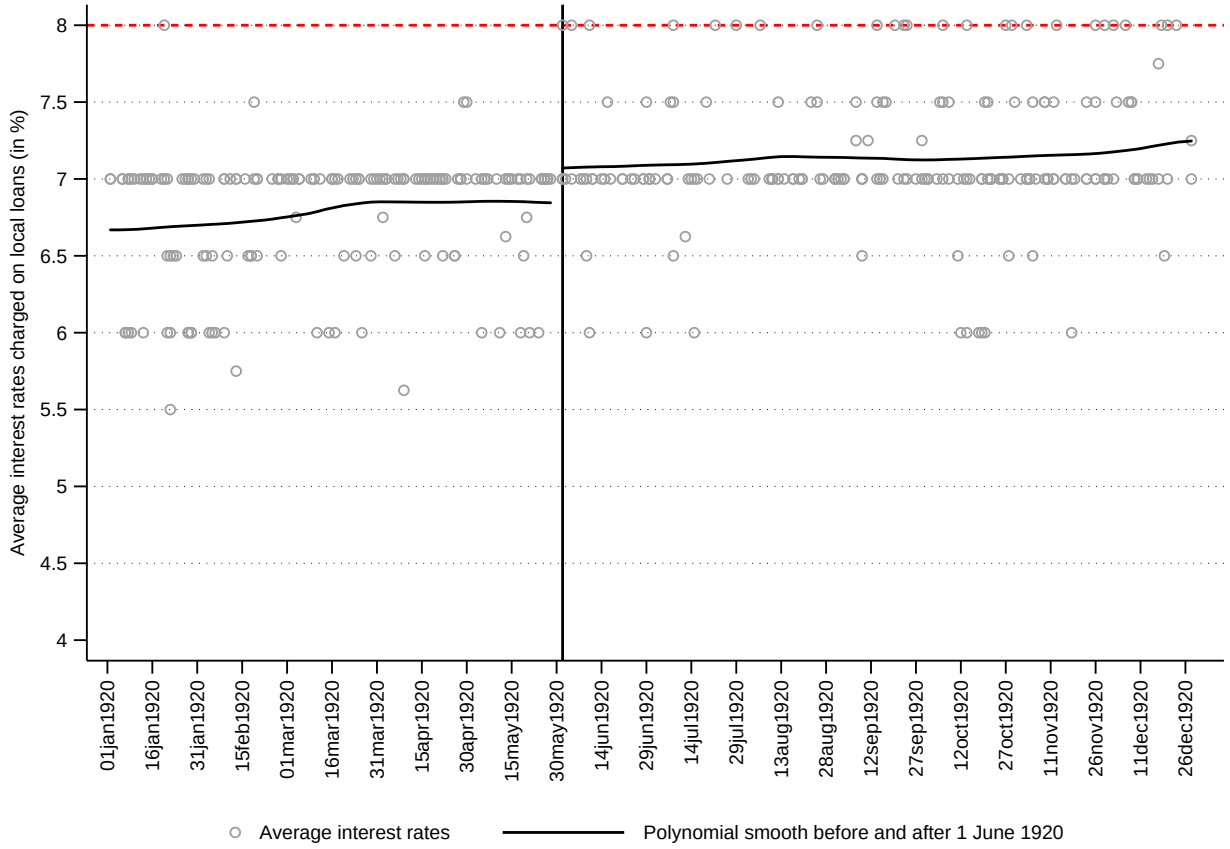
Figure 12: Interest rate on local loans charged by national banks in New Jersey in 1920



Source: National Bank Examiner Reports for 1920

Figure 12 shows bank-level interest rates on local loans (i.e. loans to local customers) charged by national banks located in New Jersey. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

Figure 13: Interest rate on local loans charged by national banks in Indiana in 1920



Source: National Bank Examiner Reports for 1920

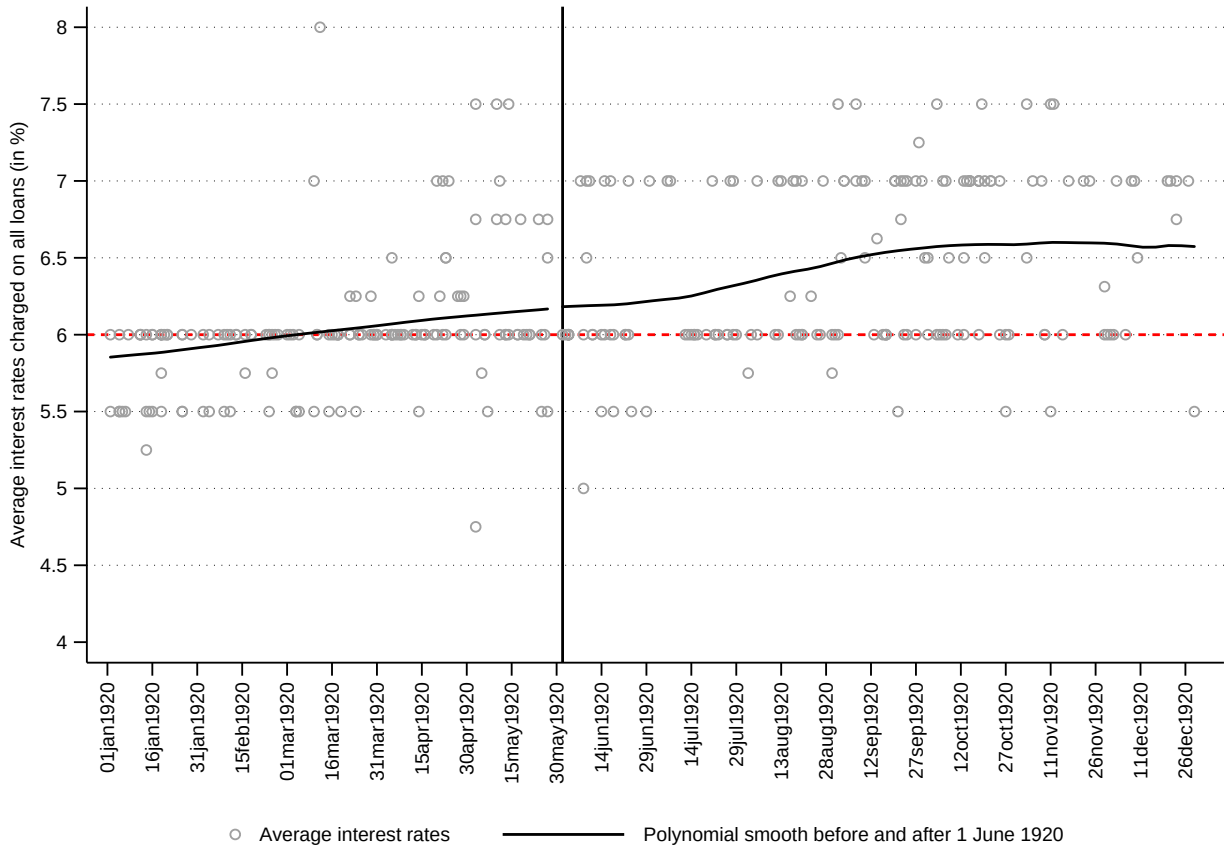
Figure 13 shows bank-level interest rates on local loans (i.e. loans to local customers) charged by national banks located in Indiana. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

Third, I provide evidence that national banks in New Jersey engaged in regulatory arbitrage to circumvent binding state usury laws, and particularly so after 1 June 1920. Instead of continuing to lend below the Federal Reserve's policy rate, national banks in New Jersey resorted to granting call loans to New York City Stock Exchange brokers and purchased non-local commercial paper in the open market. Both call loan rates and non-local commercial paper rates were exempt from the state usury rates at the time (Federal Reserve Board, 1920b; Ryan, 1924). In contrast to Figure 12, Figure 14 plots the average interest rates for all loans (rates on local loans, call loans and commercial paper purchases) for New Jersey banks. Figure 14 shows that national banks routinely circumvented the ceiling on interest rates for local loans. Although some national banks seem to have charged higher average rates already before LAW was enacted, average interest rates increased visibly during the months following 1 June 1920. A considerable number of banks began to charge 7% average rates after 1 June 1920. While the average rate on all loans before 1 June 1920 had amounted to 6.01%, it increased to 6.44% after this date. In contrast, Figure 16 in Appendix D.4 suggests that the evolution of average rates on local loans in Indiana did practically not differ from the evolution of average rates on all loans (including call loans and commercial paper purchases) in this state.[56] The same conclusion applies to national banks located in the split-PDR state of Kentucky (Figures 17 and 18 in Appendix D.4). In fact, the national examiner reports for Indiana and Kentucky demonstrate that national banks in these states almost never lent to call markets and only rarely purchased outside commercial paper.

The evidence presented suggests that New Jersey banks reacted to the combination of binding usury rates on local loans and LAW policy by shifting their credit supply to loan categories exempt from state usury laws. This narrative raises several questions. First, if regulatory arbitrage allowed treated New Jersey banks to expand their credit supply by charging a wider range of rates r, why did the banks not lend to the call and commercial paper markets before 1 June 1920, given that u^s was already binding before the introduction of LAW? Two reasons can account for the relative absence of non-local bank lending before 1 June 1920. On the one hand, call market loans did simply not constitute an attractive alternative investment option. According to a lead article in the Federal Reserve Bulletin of April 1920, call market rates remained subdued after World War I and only rose during the peak of the boom in early spring 1920 (Federal Reserve Board, 1920b). During and in the immediate aftermath of World War I, the issuance of other securities had been restricted to boost the success of government bond floatings. This form of financial repression had dampened the demand for call loans conventionally used to finance speculative stock market investments. Furthermore, banks' willingness to furnish funds to the call market initially remained low in the post-war months because of their experience with "frozen" call loans during the war: funds provided during or just before World War I had become unrealizable, illiquid assets due to the closing of the NYC stock exchange. In addition, according to the Federal Reserve Board (1920b), banks' supply of funds to the call market had also been affected by the creation of the Federal Reserve System. The establishment of the System had introduced a bias towards commercial paper lending and away from the call market: whereas the former represented eligible securities for rediscount at the Fed, loans

[56] The rate on all loans in Indiana averaged at 6.80% and 7.11% before and after 1 June 1920 respectively. Furthermore, the average rate on all loans was not statistically different from the average rate on local loans.

Figure 14: Average interest rate on all loans charged by national banks in New Jersey in 1920



Source: National Bank Examiner Reports for 1920

Figure 14 shows bank-level average interest rates on all loans (i.e. local loans, call loans and commercial paper purchases) charged by national banks located in New Jersey. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

for the purpose of carrying investment securities (other than U.S. treasury bonds) remained excluded from the central bank's rediscount facilities. Moreover, in reaction to the foundation of the Federal Reserve, the Treasury had withdrawn government funds from national banks to deposit them with the Federal Reserve Banks instead. This reduction in deposit liabilities had forced national banks to call in and to reduce their demand loans to the stock exchange.

On the other hand, national banks had always conceived their local customers as their main commercial responsibility. In the April 1920 edition of its bulletin, the Federal Reserve Board (1920b, p.371) noted that national banks also served their self-interest by concentrating on their local customer base:

> It is the universal custom of the banks to satisfy first the commercial needs of their customers. They feel an obligation to customers but none to those who borrow in the open market on securities. Besides, as the resources of the banks mainly come from the commercial customers, their own self-interest compels a preference in favor of their commercial borrowers, since failure to grant them reasonable accommodation would induce them to withdraw their deposits and so reduce the ability of the banks to do business.

This local bias of national banks' credit activities may also help to partly answer a second crucial question: why did national banks in other LAW and PDR states not resort to outside lending to the same extent as financial institutions located in the New York district? One explanation for this differential reaction to treatment could be that as long as state usury rates were not (or less) binding, banks' focus on local lending trumped the temptation to deviate credit to call markets and to purchase outside commercial paper. The greater distance to stock exchanges and the lower availability of direct commercial ties with call market brokers constitute another plausible reason for why national banks in districts other than New York engaged less in non-local lending.

In order to formally test the narrative above, I embed the data on average interest rates and lending to non-customers into my local discontinuity design in Model 1. I augment Model 1 by introducing an interaction term between the treatment dummy and the average interest rate charged by a given bank. In an alternative specification, I also draw on an interaction term between the treatment dummy and the total logarithmized sum of loans to non-customers granted by a given bank. I estimate this augmented version of Model 1 by drawing on my split state sample for New Jersey for which I collected the corresponding bank-level interest rates data and loan portfolio decompositions from individual national bank examiner reports. Table 18 in Appendix D.5 reports the results of this exercise. The crucial take-away from Table 18 is that the perverse treatment effect disappears completely once I include the interaction terms. The econometric evidence suggests that treated banks in New Jersey indeed reacted to the LAW policy by shifting their loan supply to non-local customers which enabled them to charge higher average interest rates. Thus, this shift can explain the perverse treatment effect of LAW in district 2.

6 Conclusion

In this paper, I estimate the comparative causal effects of monetary policy leaning against the wind (LAW) and macroprudential policy on bank-level credit and leverage by drawing on a single natural experiment from economic history. In 1920, when U.S. monetary policy was still decentralized, four Federal Reserve Banks implemented a conventional rate hike to address financial stability concerns. Another four Reserve Banks resorted to macroprudential policy with the same goal. Using sharp geographic regression discontinuities, I identify the treatment effects off the resulting policy borders with the remaining four Federal Reserve districts which did not change policy stance. I show that macroprudential policy caused both bank-level lending and leverage to fall significantly, whereas LAW had only weak and, in some areas, even perverse effects on these bank-level outcomes. The macroprudential tool reined in over-extended banks more effectively than LAW because it allowed Federal Reserve Banks to use price discrimination when lending to highly leveraged counterparties.

This paper contributes to the ongoing debate on the choice of optimal financial stability policies and adds new insights to the existing empirical literature on the effects of financial stability policies. First, fixing time and environment, I show that macroprudential policy is more effective than conventional monetary policy in taming bank credit. Second, my findings suggest that LAW can have severe counterproductive effects if pre-existing credit frictions lead the rate hike to incentivize regulatory arbitrage. Third, in contrast to recent empirical work on the impact of modern financial stability policies, my research design allows me to rule out violations of the stable unit treatment value assumption (SUTVA) in my setting. Finally, this paper also complements recent economic history contributions relevant to my quasi-experimental setting. It showcases the Fed's early use of sophisticated macroprudential tools and highlights that the various Federal Reserve Banks implemented different policies with quite heterogeneous effects on bank credit during the boom and bust phase of 1920-21.

The findings presented in this paper underscore the importance of economic history for modern policy-making in several ways. First, I show that history can provide us with a unique laboratory to run true "horse races" between different macroeconomic policy options. History helps us to gauge the comparative causal effects of policies in ways which have proven elusive in modern day settings. Second, my results highlight the importance of context, design and financial infrastructure for the effectiveness of financial stability policies. This paper serves as a reminder that when LAW and macroprudential policy are activated, they never enter an economic, financial and political vacuum. The impact of the very same policies can vary substantially across time and space. Third, this paper has been written at a time when central banks around the world begin to deviate from the dogma of uniform policy rates for all their counterparties.[57] My paper shows that the Federal Reserve effectively used policies involving customized price discrimination to regulate bank credit already a century ago. Looking back can be a powerful tool to enlarge the breadth of current policy debates (Eichengreen, 2012): the

[57] For example, since October 2019 the European Central Bank (ECB) charges average deposit facility rates that vary depending on the size of a counterparty's current account holdings with the central bank ("two-tier system for remunerating excess liquidity holdings"). Currently, the ECB also charges different lending rates for its targeted longer-term refinancing operations ("TLTRO"), where the level of rate charged depends on whether the borrowing bank fulfills specific lending targets. In contrast to the PDR, however, the ECB's policies aim at boosting bank lending, rather than curtailing it.

design of the progressive discount rate scheme of 1920 comes surprisingly close to modern proposals for how to conceive financial stability policies (e.g. Stein (2012)).

References

Aiyar, S., C. W. Calomiris, and T. Wieladek (2014). Does macro-prudential regulation leak? Evidence from a UK policy experiment. *Journal of Money, Credit and Banking 46*(1), 181–214.

Alam, Z., A. Alter, J. Eiseman, G. Gelos, H. Kang, M. Narita, E. Nier, and N. Wang (2019). Digging deeper—evidence on the effects of macroprudential policies from a new database. *IMF Working Paper 2019*(66), 1–57.

Anbil, S. (2018). Managing stigma during a financial crisis. *Journal of Financial Economics 130*(1), 166–181.

Anderson, H., C. W. Calomiris, M. Jaremski, and G. Richardson (2018). Liquidity risk, bank networks, and the value of joining the Federal Reserve System. *Journal of Money, Credit and Banking 50*(1), 173–201.

Anson, M., D. Bholat, M. Kang, and R. Thomas (2017). The Bank of England as lender of last resort: new historical evidence from daily transactional data. *Bank of England Staff Working Paper 2017*, 1–89.

Araujo, J., M. Patnam, A. Opescu, F. Valencia, and W. Yao (2020). Effects of macroprudential policy: Evidence from over 6,000 estimates. *IMF Working Paper 2020*(67), 1–53.

Barroso, J. B. R. B., R. B. Gonzalez, and B. F. Nazar Van Doornik (2017). Credit supply responses to reserve requirements: loan-level evidence from macroprudential policy. *BIS Working Paper 674*, 1–41.

Bergant, K., F. Grigoli, N. Hansen, and D. Sandri (2020). Dampening global financial shocks in emerging markets: Can macroprudential regulation help? *IMF Working Paper 2020*(20), 1–41.

Bordo, M. D. and A. Sinha (2016). A lesson from the Great Depression that the Fed might have learned: a comparison of the 1932 open market purchases with quantitative easing. *Hoover Institution Economics Working Papers 16113*, 1–75.

Borio, C. (2014). The financial cycle and macroeconomics: what have we learnt? *Journal of Banking & Finance 45*, 182–198.

Caballero, R. J. and A. Simsek (2020). Prudential monetary policy. *MIT Economics Department Working Paper* (Unpublished manuscript), 1–58.

Calomiris, C. W. (1989). Deposit insurance: Lessons from the record. *Federal Reserve Bank of Chicago Economic Perspectives* (5/6), 10–30.

Camors, C. D., J. L. Peydró, and F. R. Tous (2017). Macroprudential and monetary policy: loan-level evidence from reserve requirements. *AEA Annual Meeting 2017 Conference Paper* (Unpublished manuscript), 1–43.

Carlin, B. and W. Mann (2019). The real effects of Fed intervention during the 1920-21 depression. *UCLA Anderson School of Management Working Paper* (Unpublished manuscript), 1–61.

Carlson, M. and B. Duygan-Bump (2018). "Unconventional" monetary policy as conventional monetary policy: a perspective from the U.S. in the 1920s. *Federal Reserve Board Finance and Economics Discussion Series* (19), 1–45.

Carlson, M. and K. Mitchener (2006). Branch banking, bank competition, and financial stability. *Journal of Money, Credit and Banking 38*(5), 1293–1328.

Carlson, M. and K. Mitchener (2009). Branch banking as a device for discipline: Competition and bank survivorship during the Great Depression. *Journal of Political Economy 117*(2), 165–210.

Cerra, V. and S. C. Saxena (2008). Growth dynamics: the myth of economic recovery. *American Economic Review 98*(1), 439–57.

Cohen-Setton, J. (2016). The making of a monetary union: evidence from the U.S. discount market 1914-1935. *University of California, Berkeley* (Unpublished manuscript), 1–48.

Collard, F., H. Dellas, B. Diba, and O. Loisel (2017). Optimal monetary and prudential policies. *American Economic Journal: Macroeconomics 9*(1), 40–87.

Conley, T. (1999). GMM estimation with cross sectional dependence. *Journal of Econometrics 92*(1), 1–45.

Cordella, T., P. Federico, C. Vegh, and G. Vuletin (2014). *Reserve Requirements in the Brave New Macroprudential World*. Washington D.C.: International Bank for Reconstruction and Development / The World Bank.

Eichengreen, B. (2012). Economic history and economic policy. *Journal of Economic History 72*(2), 289–307.

Farhi, E. and I. Werning (2016). A theory of macroprudential policies in the presence of nominal rigidities. *Econometrica 84*(5), 1645–1704.

Federal Reserve Board (1919-1920a). *Federal Reserve Bulletin*. Various issues. Washington D.C.: Government Printing Office.

Federal Reserve Board (1920b). *Federal Reserve Bulletin*. April 1920 Issue. Washington D.C.: Government Printing Office.

Federal Reserve Board (1920c). *Letter by Governor Harding to the Secretary of the Treasury and the Comptroller of the Currency*. Mimeograph Letters and Statements of the Board of Governors of the Federal Reserve System (Volume 12, January-June 1920), Document number X-1941. Washington D.C.: Board of Governors of the Federal Reserve System.

Federal Reserve Board (1920d). *Minutes of the Board of Governors of the Federal Reserve System (14 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920e). *Minutes of the Board of Governors of the Federal Reserve System (16 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920f). *Minutes of the Board of Governors of the Federal Reserve System (21 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920g). *Minutes of the Board of Governors of the Federal Reserve System (28 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920h). *Minutes of the Board of Governors of the Federal Reserve System (30 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920i). *Notes on the Governors conference held on 17 April 1920*. Mimeograph Letters and Statements of the Board of Governors of the Federal Reserve System (Volume 12, January-June 1920), Document number X-1906. Washington D.C.: Board of Governors of the Federal Reserve System.

Federal Reserve Board (1920j). *Sixth annual report of the Federal Reserve Board covering the operations for the year 1919*. Volume I. Washington D.C.: Government Printing Office.

Federal Reserve Board (1921). *Seventh annual report of the Federal Reserve Board covering the operations for the year 1920*. Volume I. Washington D.C.: Government Printing Office.

Federal Reserve Board (1922). *Eighth annual report of the Federal Reserve Board covering the operations for the year 1921*. Washington D.C.: Government Printing Office.

Federal Reserve Board (1923). *Federal Reserve Board conference on 18 May 1920 - Minutes of conference with the Federal Reserve Board of the Federal Advisory Council and the class A directors of the Federal Reserve Banks*. Washington D.C.: Government Printing Office.

Feenberg, D. and J. A. Miron (1995). Improving the accessibility of the NBER's historical data. *Journal of Business and Economic Statistics 15*(3), 293–299.

Forbes, K. J. (2019). Macroprudential policy: What we've learned, don't know, and need to do. *AEA Papers and Proceedings 109*, 470–475.

Friedman, M. and A. J. Schwartz (1963). *A monetary history of the United States, 1867-1960*. Studies in business cycles. Princeton: Princeton University Press.

Gambacorta, L. and F. M. Signoretti (2014). Should monetary policy lean against the wind? An analysis based on a DSGE model with banking. *Journal of Economic Dynamics and Control 43*, 146–174.

Goldenweiser, E. A. (1925). *Federal Reserve System in operation*. New York: McGraw-Hill Book Company.

Gorton, G. and A. Metrick (2013). The Federal Reserve and panic prevention: the roles of financial regulation and lender of last resort. *Journal of Economic Perspectives 27*(4), 45–64.

Gorton, G. and G. Ordoñez (2014). Collateral crises. *American Economic Review 104*(2), 343–78.

Gourio, F., A. K. Kashyap, and J. W. Sim (2018). The trade-offs in leaning against the wind. *IMF Economic Review 2018*(66), 70–115.

Hackley, H. H. (1973). *Lending functions of the Federal Reserve Banks: a history*. Washington D.C.: Publications Services, Division of Administrative Services, Board of Governors of the Federal Reserve System.

Haines, M., P. Fishback, and P. Rhode (2016). United States agriculture data, 1840 - 2012. *ICPSR35206-v3 (Agricultural Census 1920)*.

Hausman, J. K. (2016). Fiscal policy and economic recovery: the case of the 1936 veterans' bonus. *American Economic Review 106*(4), 1100–1143.

IMF (2015). Monetary policy and financial stability. Staff report, International Monetary Fund.

Jalil, A. J. (2014). Monetary intervention really did mitigate banking panics during the Great Depression: evidence along the Atlanta Federal Reserve District border. *Journal of Economic History 74*(1), 259–273.

Jaremski, M. and D. C. Wheelock (2017). Banker preferences, interbank connections, and the enduring structure of the Federal Reserve System. *Explorations in Economic History 66*, 21–43.

Jaremski, M. and D. C. Wheelock (2020a). Banking on the boom, tripped by the bust: banks and the World War I agricultural price shock. *Journal of Money, Credit and Banking* (Forthcoming), 1–32.

Jaremski, M. and D. C. Wheelock (2020b). The founding of the Federal Reserve, the Great Depression, and the evolution of the U.S. interbank network. *Journal of Economic History 80*(1), 69–99.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2017). Macroprudential policy, countercyclical bank capital buffers, and credit supply: evidence from the Spanish dynamic provisioning experiments. *Journal of Political Economy 125*(6), 2126–2177.

Johnson, C. and T. Rice (2007). Assessing a decade of interstate bank branching. *Federal Reserve Bank of Chicago Working Paper Series 3*, 1–46.

Joint Commission of Agricultural Enquiry (1922). *Report of the Joint Commission of Agricultural Enquiry*. Part II: Credit. Washington D.C.: Government Printing Office.

Martinez-Miera, D. and R. Repullo (2019). Monetary policy, macroprudential policy, and financial stability. *Annual Review of Economics 11*, 809–832.

Meltzer, A. H. (2003). *A history of the Federal Reserve*. Chicago; London: University of Chicago Press.

Mitchener, K. J. (2005). Bank supervision, regulation, and instability during the Great Depression. *Journal of Economic History 65*(1), 152–185.

Mitchener, K. J. and G. Richardson (2013). Shadowy banks and financial contagion during the Great Depression: a retrospective on Friedman and Schwartz. *American Economic Review 103*(3), 73–78.

Mitchener, K. J. and G. Richardson (2019). Network contagion and interbank amplification during the Great Depression. *Journal of Political Economy 127*(2), 465–507.

Oehmke, M. (2014). Liquidating illiquid collateral. *Journal of Economic Theory 149*, 183–210.

Office of the Comptroller of the Currency (1920). *Annual report of the Comptroller of the Currency on December 1, 1919*. Volume II. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1921a). *Annual report of the Comptroller of the Currency on December 6, 1920*. Volume I. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1921b). *Annual report of the Comptroller of the Currency on December 6, 1920*. Volume II. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1922). *Annual report of the Comptroller of the Currency on December 5, 1921*. Volume II. Washington D.C.: Government Printing Office.

Rajan, R. and R. Ramcharan (2015). The anatomy of a credit crisis: the boom and bust in farm land prices in the United States in the 1920s. *American Economic Review 105*(4), 1439–1477.

Rajan, R. and R. Ramcharan (2016). Local financial capacity and asset values: evidence from bank failures. *Journal of Financial Economics 120*(2), 229 – 251.

Rand McNally bankers directory (1920). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 48th edition, Jan 1920. New York: Rand McNally & Company, Publishers.

Rand McNally bankers directory (1921a). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 50th edition, Jan 1921. New York: Rand McNally & Company, Publishers.

Rand McNally bankers directory (1921b). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 51th edition, Jul 1921. New York: Rand McNally & Company, Publishers.

Reinhardt, D. and R. Sowerbutts (2017). Regulatory arbitrage in action: evidence from banking flows and macroprudential policy. *AEA Annual Meeting 2017 Conference Paper* (Unpublished manuscript), 1–37.

Rey, H. (2013). Dilemma not trilemma: the global financial cycle and monetary policy independence. *Federal Reserve Bank of Kansas City Economic Policy Symposium, Jackson Hole Conference*, 1–41.

Richardson, G. and W. Troost (2009). Monetary intervention mitigated banking panics during the Great Depression: quasi-experimental evidence from a Federal Reserve district border, 1929–1933. *Journal of Political Economy 117*(6), 1031–1073.

Romer, C. D. and D. H. Romer (2017). New evidence on the aftermath of financial crises in advanced countries. *American Economic Review 107*(10), 3072–3118.

Rotemberg, J. J. (2013). Shifts in us federal reserve goals and tactics for monetary policy: A role for penitence? *Journal of Economic Perspectives 27*(4), 65–86.

Ryan, F. W. (1924). *Usury and usury laws: a juristic-economic study of the effects of state statutory maximums for loan charges upon lending operations in the United States*. Boston; New York: Houghton Mifflin Company - Riverside Press Cambridge.

Schularick, M. and A. M. Taylor (2012). Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870-2008. *American Economic Review 102*(2), 1029–61.

Schularick, M., L. ter Steege, and F. Ward (2020). Leaning against the wind and crisis risk. *CEPR Discussion Paper 2020*(14797), 1–42.

Smets, F. (2014). Financial stability and monetary policy: how closely interlinked? *International Journal of Central Banking June*, 263–300.

Stein, J. C. (2012). Monetary policy as financial stability regulation. *Quarterly Journal of Economics 127*(1), 57–95.

Stein, J. C. (2013). Overheating in credit markets: origins, measurement, and policy responses. Research symposium, Federal Reserve Bank of St. Louis.

Stiglitz, J. E. and A. Weiss (1981). Credit rationing in markets with imperfect information. *American Economic Review 71*(3), 393–410.

Svensson, L. E. (2016). Cost-benefit analysis of leaning against the wind: are costs larger also with less effective macroprudential policy? *IMF Working Paper 2016*(3), 1–76.

Svensson, L. E. (2017). Cost-benefit analysis of leaning against the wind. *Journal of Monetary Economics 90*, 193–213.

Tallman, E. and E. N. White (2020). Why was there no banking panic in 1920-21? The Federal Reserve Banks and the recession. *ASSA Annual Meetings 2020 EHA Sessions* (Unpublished manuscript), 1–40.

Temin, P. and H. Voth (2008). Interest rate restrictions in a natural experiment: Loan allocation and the change in the usury laws in 1714. *Economic Journal 118*(528), 743–758.

Wallace, R. F. (1956). The use of the progressive discount rate by the Federal Reserve System. *Journal of Political Economy 64*(1), 59–68.

Wood, E. (1939). *English theories of central banking control, 1819-1858: with some account of contemporary procedure*. Harvard economic studies; Vol. LXIV. Cambridge: Harvard University Press.

Appendix

Appendix A: Historical context and identification strategy

Appendix A.1: The post-World War I boom

The origins of the boom partly lay in an overly accommodative monetary policy, reminiscent of more recent episodes. Fiscal dominance during the Great War led to an environment of low interest rates that catered to the need of government finance (Friedman and Schwartz, 1963; Meltzer, 2003). Accommodative monetary policy was enforced by the Treasury through 1919 to ensure an easy placement of the government's Victory bonds. When the Federal Reserve started to regain full control over its interest rates in early 1920, commercial banks had already taken advantage of discount rates below market rates. Until the mid-1920s, no "stigma" was attached to the use of the System's standard credit facilities, and commercial banks thus had extensive recourse to the System as an additional source of funding (Gorton and Metrick, 2013). Between July 1919 and May 1920, loan portfolios of national banks increased by 22% on average (Office of the Comptroller of the Currency, 1921a). Figure 1 shows the monthly flows of bills discounted by the Federal Reserve System between 1915 and 1922. The System greatly expanded its operations after the American entry into World War I. Monthly rediscounting flows remained high long after armistice on 11 November 1918 and only plummeted during the recession of 1920-21.

Figure 1: Monthly flows of bills discounted by the Federal Reserve System between 1915 and 1922

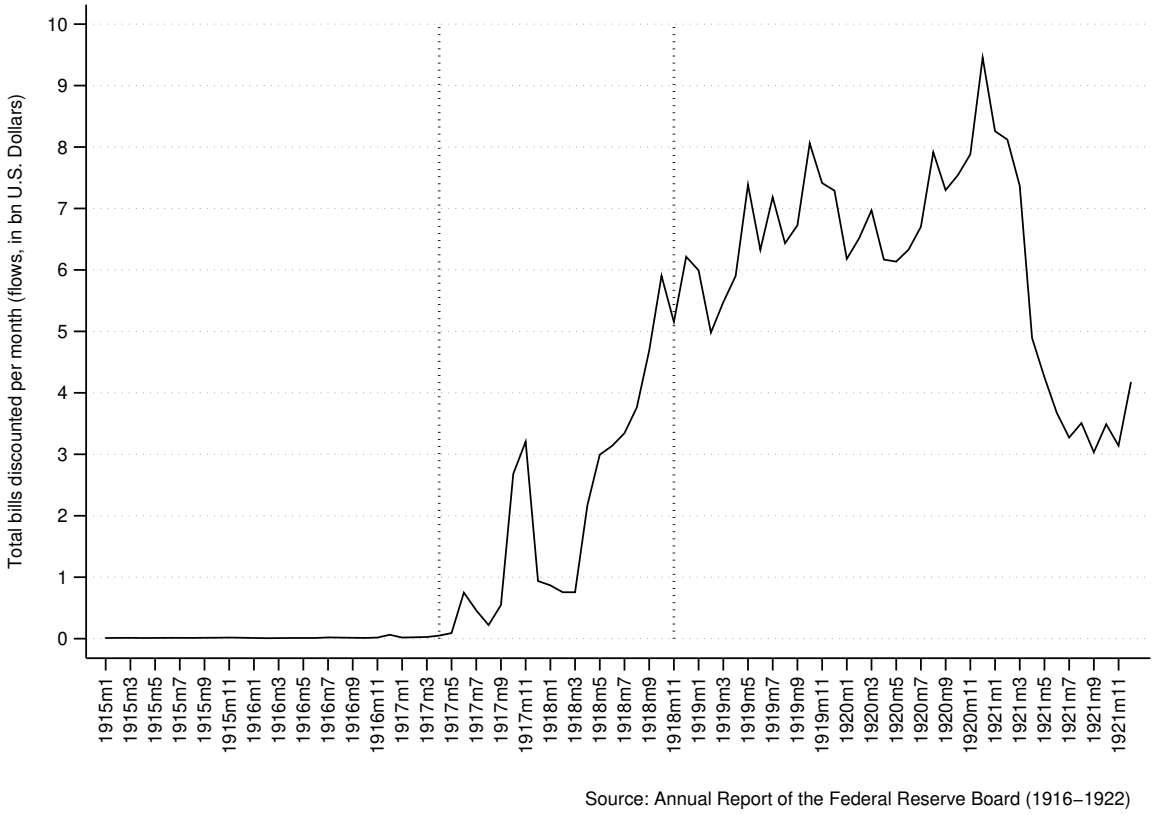


Figure 1 shows the monthly flows of bills discounted by the Federal Reserve System between 1915 and 1922. The vertical lines correspond to the entry of the United States into World War I (6 April 1917) and armistice (11 November 1918).

Goldenweiser (1925, p.27) documents a change in the type of credit expansion away from government debt and war finance to private consumption after summer 1919. The congressional Joint Commission of Agricultural Enquiry (1922, p.42) described the investments in "personal indulgences, high priced land and worthless oil stocks" as an "orgy of spending". Loans supported the restocking of shelves and inventories, the desire to increase meat and wheat consumption but also reacted to a "heavy demand for new dwellings, as building activities for private use had been on a greatly reduced scale during the war" (Goldenweiser, 1925, p.30). Simultaneously, the collapse of European agricultural production during World War I acted as a positive demand shock for U.S. producers and spurred a commodity price boom. Crop prices soared and subsequently boosted farm land prices (Rajan and Ramcharan, 2015). Commercial banks became increasingly involved in the farm land price boom as they provided farm mortgages for the expansion of cultivated land and other secured loans for the purchase of farming equipment (Jaremski and Wheelock, 2020).[1] Figure 2 plots the price index for four major traded agricultural commodities whose evolution reflects both the boom and bust phases in the aftermath of World War I.

Figure 2: Price index for traded agricultural commodities (January 1919 - December 1921)

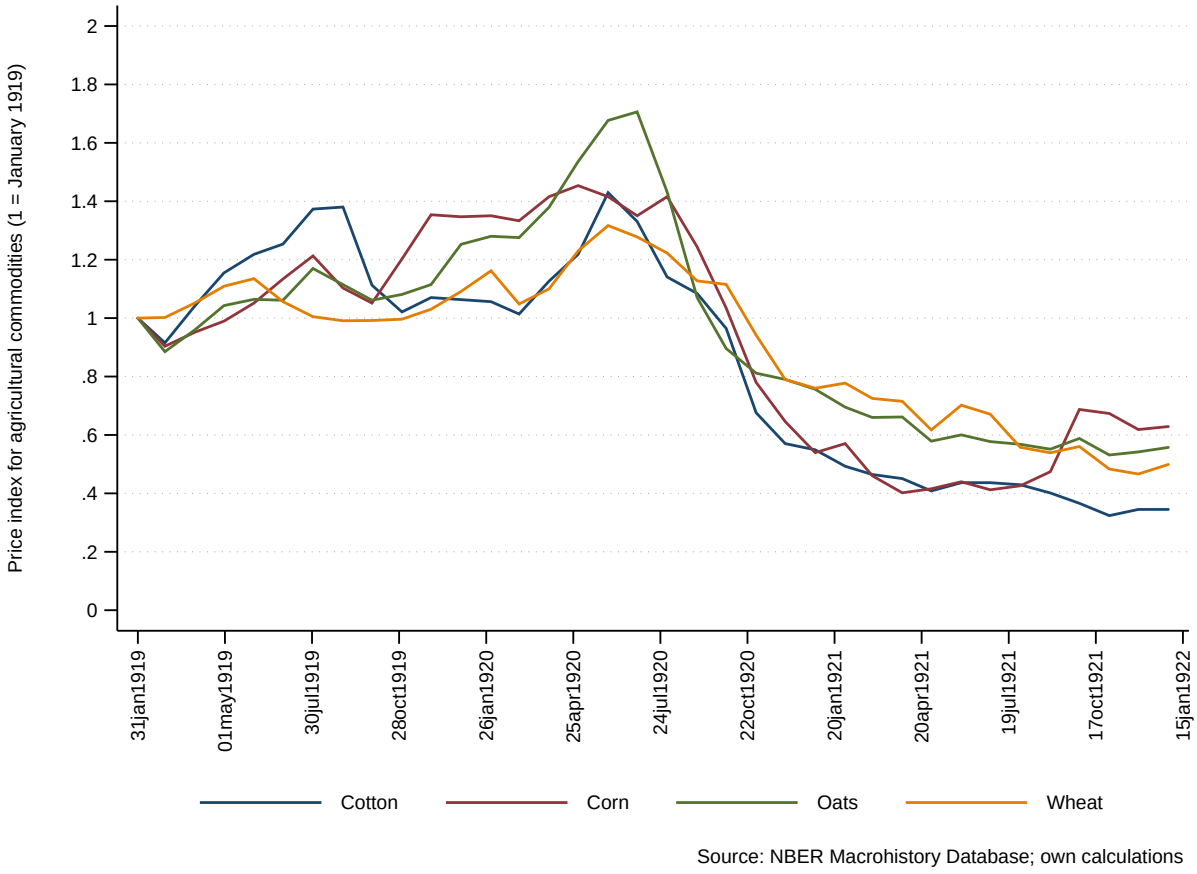


Figure 2 shows a price index for the four major traded agricultural crops between January 1919 and December 1921.

[1] Jaremski and Wheelock (2020) acknowledge, however, that national banks were restricted in their rights to grant mortgage loans to farmers. National banks were only allowed to grant farm mortgages if they were not situated in central reserve cities. In addition, the mortgaged land needed to be unencumbered and the mortgage could not exceed a loan-to-value ratio of 50%. Furthermore, on aggregate, mortgage loans could not exceed 25% of the bank's capital and surplus or one third of its time deposits. Finally, starting in 1916, the maximum maturity for national bank mortgage loans was reduced from five years to one year. Hence, the vast majority of farm mortgages came from non-banks.

Appendix A.2: Experiment validity

Leaning against the wind (LAW) is conventionally defined as "monetary policy that is somewhat tighter (that is, with a somewhat higher policy interest rate) than what is consistent with flexible inflation targeting without taking any effects on financial stability into account" (Svensson, 2017, p.193). Although this definition seems specific to the practice of modern inflation-targeting central banks, it can be reformulated in a more general way: LAW requires raising the policy rate above the level indicated by the central bank's policy rule to halt an asset price boom or a credit boom that is deemed unsound by the monetary authority.[2] This definition of LAW raises two questions of crucial importance for this paper. First, did the motivation behind the Federal Reserve Banks' policy reaction in late spring 1920 correspond to that of a proper LAW operation? To demonstrate that I am exploiting a valid natural experiment for LAW, the Federal Reserve System's policy rule(s) at the time must not fully explain the policy decisions taken by Federal Reserve Banks. Second, what exactly were the financial developments which the Federal Reserve Banks wished to address? For the setting to be valid, a case must be made that Federal Reserve Banks regarded specific financial developments as unsound and referred to these developments as a major motivation for LAW. Both points also apply to the use of macroprudential policy. If the use of the progressive discount rate was a simple outgrow of policy rules and/or did not pursue any financial stability considerations, this paper would fail to address its main research question.

Policy rules followed by the Federal Reserve System in 1920

To start with, a clear description of the Federal Reserve System's policy rules, as practiced in 1920, is needed. The doctrinal determinants of Federal Reserve Policies during the first two decades of its existence were hotly contested at the time and even continue to be subject to debate today (Eichengreen, 2016). Previous work on this topic shows that any too rigid classification of policy decisions during that time would likely amount to a gross simplification, given the complex historical context and the confusion among Federal Reserve officials themselves which macroeconomic indicators, and thus policies, should be followed in certain circumstances.[3] Despite these difficulties, most authors would agree that two policy rules in particular shaped the reaction function of the Federal Reserve System by 1920.[4] One the one hand, the Federal Reserve Act obliged the System as a whole, as well as the individual Federal Reserve Banks, to abide by specific gold reserve requirements. The System and the Reserve Banks had to maintain reserves of 35% in gold or lawful money against member bank deposit liabilities[5],

[2] LAW is fundamentally different from countercyclical monetary policy for two reasons. First, by definition, LAW goes beyond the standard policy reaction function: a policy rate hike in response to a positive output gap would not correspond to LAW because it fully follows from a modern central bank's policy rule. Second, in contrast to countercyclical policy, LAW is usually asymmetric: LAW is associated with policy rate increases but not with rate cuts. In theory, leaning against wind of falling asset prices and credit crunches is thinkable, but it would be much more difficult to disentangle this policy from conventional policy actions, especially given the zero lower bound of nominal interest rates.

[3] The exact content of these discussions is beyond the scope of this paper. For more encompassing treatments, c.f. Friedman and Schwartz (1963) and Meltzer (2003). Humphrey (2001) and Eichengreen (2016) shed more light on the debates in the 1920s. More specifically, Tallman and White (2020) discuss Federal Reserve Policies during the 1920-1921 crisis. Richardson and Troost (2009) discuss this topic in the context of the U.S. Great Depression.

[4] The fact that the two policy rules described below may at times conflict is emblematic for the first formative decades of Federal Reserve history.

[5] These deposit liabilities consisted mostly of required reserves paid in by Federal Reserve member banks, i.e. all national banks, but also state-chartered banks that had decided to become Federal Reserve members.

and a 40% reserve in gold against Federal Reserve notes.[6] Reserve requirements were directly connected to the United States' adherence to the Gold Standard: deposits and Federal Reserve notes could be redeemed in gold or lawful money at any time.[7] Thus, true to the gold reserve ratio tradition of most European central banks before 1914, one conventional policy rule followed by the Federal Reserve System was to increase the policy rate whenever the reserve ratio had shrunk to values close to 40%. This increase aimed at producing a domestic monetary contraction and attracting foreign gold reserves, strengthening the System's own reserves.

On the other hand, the Federal Reserve Board and the Reserve Banks informed their policy by drawing on various (sometimes conflicting) interpretations of the so called "real bills doctrine" (Humphrey, 2001). This doctrine requires a central bank to lend exclusively for the purpose of (re)financing the legitimate needs of commerce: the focus is on the rediscount of "real bills", that is, bills of exchange drawn in order to pre-finance a commercial transaction, such as the sale of goods, with delayed payment. In principle, these bills should be self-liquidating at maturity in the sense that the underlying real transaction comes to an automatic close after the payment for the shipment of goods has been completed. As long as a central bank only rediscounts commercial bills, so the doctrine goes, speculative use of central bank credit is ruled out. Apart from a thorough screening of the bills submitted for rediscount, the real bills view imagines the central bank as a rather passive entity. In order to best accommodate commerce, the policy rule implied by the real bills doctrine simply requires the monetary authority to adjust its discount rate to the currently prevailing market rate.[8]

Policy rules and the adoption of financial stability policies

Can these two policy rules fully account for the interest rate decisions taken by the Federal Reserve Banks in 1920? Several prior contributions discuss this question. The relative importance of the gold reserve ratio for Federal Reserve policy decisions in 1920 figures at the heart of this debate. Friedman and Schwartz (1963, p.237-239) assert that the reserve position of the System was an inadequate justification for the policy followed in the spring of 1920 for at least three reasons: "In the first place, [the reserve position] would never have become as tight as it did except for the easy money policy of 1919. In the second place, it improved so rapidly after late 1920 that it almost surely would have improved even with a much easier policy. In the third place, the Board had the legal power at any time to suspend the reserve requirements temporarily at only negligible cost."

While Friedman and Schwartz (1963) anchor their argument in an economic critique of the motivations for hiking policy rates, Wicker (1966, p.225) affirms that the System would have maintained high rates even if the

[6] In practice, the Board and the Federal Reserve Banks always monitored the combined reserve position computed as the ratio of total cash reserves (including gold) to the sum of net deposits and Federal Reserve notes.

[7] After the United States entered World War I in 1917, a gold embargo prohibited the export of gold abroad. The ban was lifted again in summer 1919.

[8] Sometimes, proponents also argued for a penalty surcharge on top of market rates, effectively merging the doctrine with the rules for last resort lending proposed by Walter Bagehot (1873). As pointed by Humphrey (2001, p.287), the real bills doctrine had several other important ramifications. For example, the doctrine convinced some Federal Reserve officials that prices and output caused fluctuations in the money supply rather than vice versa, and that the System had no control over the money supply.

legal reserve constraint had been entirely absent. In his opinion, the gold reserve ratio was only included in the Federal Reserve Act in the first place because the country was accustomed to fixed reserve requirements of some sort due to the legacy of the national banking era. At the time when the Federal Reserve Act was passed, the responsible House Committee was very much aware of the fact that the gold reserve requirement would be counterproductive to the creation of an elastic currency but regarded its suspension during moments of emergency as an adequate safeguard (Wicker, 1966, p.229).[9] According to Wicker (1966, p.237), the most important rationale for Federal Reserve policy in the spring of 1920 was the System's concern about a looming financial crisis, with a particular concern for the liquidity of the banking system and the over-expansion of credit. Although Wicker (1966, p.238) acknowledges that any attempt to slow member bank credit expansion is not inconsistent with, but rather complementary to a defense of the gold reserve[10], he argues that "purely domestic credit considerations exercised a greater influence on policy than did the statutory requirements connected with the maintenance of the gold standard in the United States." More recently, Meltzer (2003, p.104) suggests that the gold reserve ratio was a key reason for the rate increase in 1920. The author also emphasizes, however, that the Federal Reserve System did not rely on the gold reserve ratio to guide its discount policy in the context of the ensuing recession when high reserve ratios would have warranted a decrease in the main policy rate (Meltzer, 2003, p.121).

I argue that the key to understanding the motivations driving Federal Reserve policy is to disaggregate, both, instances of policy decisions and the different policies of Federal Reserve Banks. Prior contributions discussing Federal Reserve policy in 1920 mostly lack this detailed perspective.[11] It is enlightening to separate the Federal Reserve Banks' interest rate decisions in 1920 into two different episodes, according to their timing. In a first wave of policy decisions, all Federal Reserve Banks uniformly increased their commercial paper rate to 6% between 23 January and 2 February 1920. In the case of most districts, this first rate hike was implemented as a one-off, sweeping increase from 4.75% to 6%.[12] The meeting minutes of the Federal Reserve Board show that this first wave of rate increases was initially recommended by the Federal Reserve Bank of Boston on 15 January 1920. The recommendation appeared on the agenda shortly after the New York Reserve Bank had been requested by the Board to rediscount with other Federal Reserve Banks in order to meet its reserve requirements against deposit liabilities on 14 January 1920 (Federal Reserve Board, 1920b,c). This uniform rate hike to 6% was by no means uncontroversial among Board members.[13] Once the changes had been accepted for the Eastern districts, however, the Board unilaterally enforced the 6% rate also for the Dallas and San Francisco Reserve Banks, whose directors would have preferred a rate of 5.5% at the time (Federal Reserve Board, 1920e,f).

[9] This interpretation thus likens the System's adherence to reserve requirements to the gold reserve tradition followed by the Bank of England in the late 19th century. The Bank of England had its cover requirement routinely suspended when it needed to expand its lending during crises (Bignon et al., 2012).

[10] Member bank credit expansion can be mechanically related to borrowing from the Federal Reserve System if granting loans involves deposit creation and thus higher absolute reserve requirements.

[11] In an ongoing project tangential to this paper, Tallman and White (2020) disaggregate Federal Reserve Banks' credit supply and its determinants in 1920-1921.

[12] Some Reserve Banks increased the rate more gradually (Dallas, Kansas City and Cleveland), although all reached the same level of 6% by 2 February 1920.

[13] Friedman and Schwartz (1963, p.229-231) provide a discussion based on primary sources. The debates are also reflected in the Board meeting minutes (Federal Reserve Board, 1920d).

The uniform rate hike in January 1920 corresponds to a decision taken first and foremost in response to one of the System's policy rules. Figure 3 shows the combined reserve ratio (before any interdistrict accommodation[14]) by district in 1920. In January 1920, seven of the 12 Federal Reserve districts had reserve ratios close to the legal limit and five districts would have violated the limit had they not received interdistrict accommodation. In addition, the fact that the Board pushed Dallas and San Francisco to hike rates suggests that the System really considered its overall reserve position to be a precarious one. Before 1935, the Board made use of its statutory right to enforce a discount rate different from the one proposed by a Federal Reserve Bank on only one other occasion, namely in September 1927 (Cohen-Setton, 2016, p.18). Both primary sources and the contemporary literature argue that the increase in policy rates was rendered imperative by the declining reserve positions of Federal Reserve Banks. In an official letter to the Secretary of Treasury and the Comptroller of Currency posted on 29 May 1920, Federal Reserve Board Governor Harding explained that "the primary purpose of the advances recently made in discount rates at Federal Reserve Banks has been to protect the reserves of the Federal Reserve Banks and to discourage undue expansion of loans by the member banks"(Federal Reserve Board, 1920a, p.481). Contemporary economist Sprague (1921, p.23) confirms this rationale: "The successive advances in discount rates made during the first half of the year were not then entirely the expression of a voluntary policy. It was a policy which in large measure was enforced by the reserve position of the [Federal Reserve] banks."

[14]Interdistrict accommodation describes the act of one Federal Reserve Bank borrowing from another Federal Reserve Bank, c.f. **?** and Tallman and White (2020).

Figure 3: Combined reserve ratio of Federal Reserve Banks in 1920 (before interdistrict accommodation)

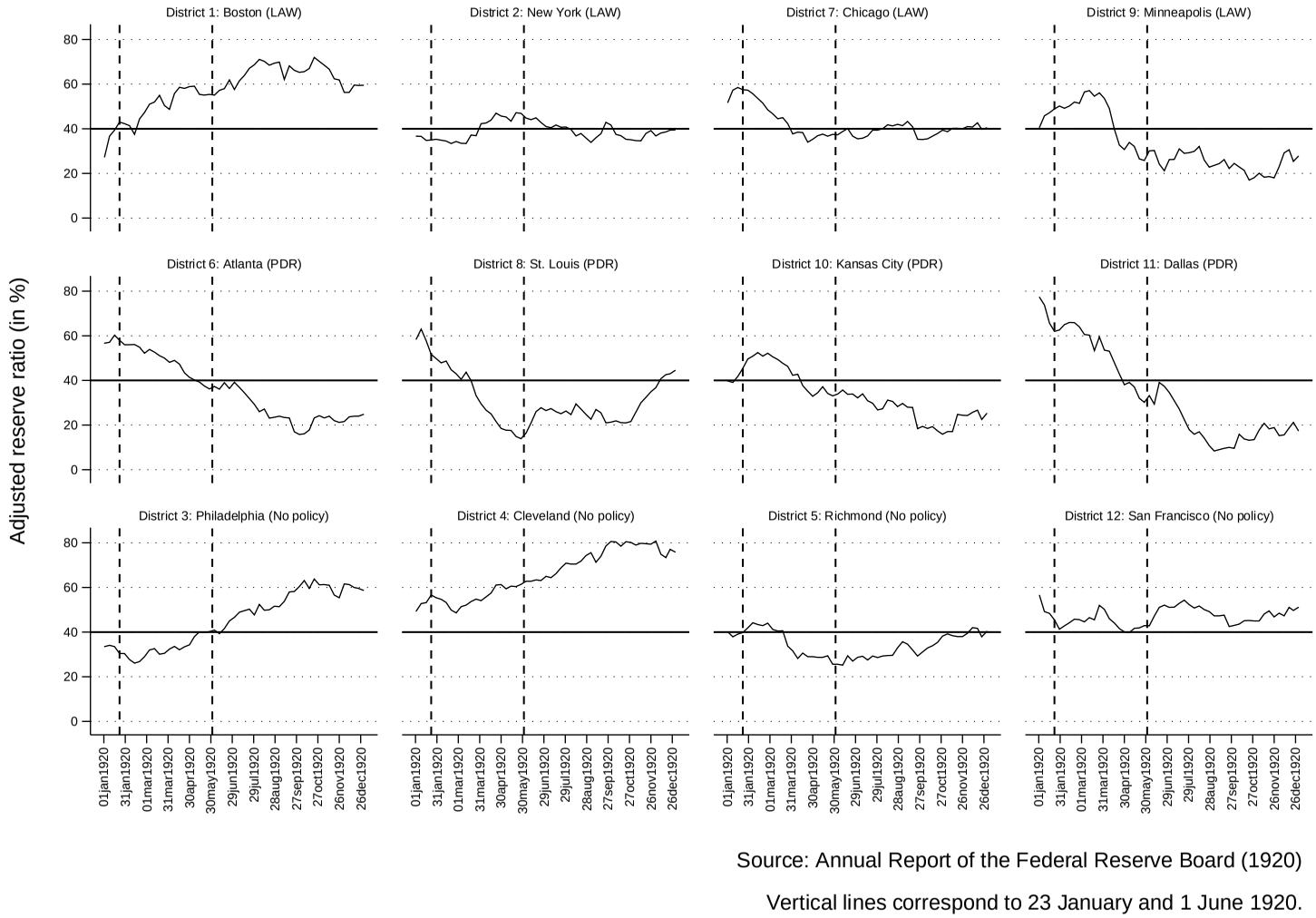


Figure 3 shows the adjusted gold reserve ratios of Federal Reserve Banks. The adjusted reserve ratio is different from the gross reserve ratio which includes interdistrict borrowing from other Federal Reserve Banks to meet the legal reserve requirement. The gross reserve ratio never fell below the minimum required reserves (40% gold reserves against outstanding Federal Reserve notes). Hence, to obtain a more informative picture of the pressures experienced in the different Federal Reserve districts, I calculate the adjusted reserve ratio net of interdistrict borrowing. The horizontal line at 40% indicates the minimum gold reserve ratio Federal Reserve Banks had to maintain at the time.

The second wave of policy decisions followed in late spring 1920. In contrast to the January decisions, the second round of policy decisions differed substantially across districts. While the uniform rate hike in January 1920 is most convincingly explained by the gold reserve position of the System, the renewed policy action in late spring was motivated primarily by financial stability concerns beyond the narrow straitjacket of the System's policy rules. Primary sources documenting the run-up to and the arguments behind the decisions in late spring 1920 confirm this view. Between January and June 1920, it became clear that the Reserve Bank governors "differed chiefly as to the degree in which liquidation has been brought about by [January] increases in discount rates. Several governors reported no liquidation directly traceable to that cause" (Federal Reserve Board, 1920g, p.489). In a joint conference of the Federal Reserve Board, the Federal Advisory Council and the class A directors[15] of the Federal Reserve Banks held on 18 May 1920, the situation of the different districts was discussed one by one, including the directors' stance vis-à-vis an additional rise in the policy rates (Federal Reserve Board, 1923). Table 1 summarizes the comments made by the Federal Reserve Bank directors on this occasion. Only two Federal Reserve Banks argued in favor of a rate hike to 7% (New York and Chicago), one was indifferent (Kansas City) and three districts declared themselves against an increase but had either dissenting internal voices (San Francisco) or showed some policy flexibility in case it was required by the System (Cleveland and Atlanta); all other districts strictly opposed the idea of another increase in the discount rate in late spring. Thus, at least as far as policy intentions are concerned, the System was deeply divided by mid-May 1920: another uniform increase in policy rates to protect the reserve position was clearly not on the table.

Instead, financial stability concerns were the major motivation for the tighter monetary policy enacted by some Federal Reserve Banks in late spring 1920. The main purpose of the joint conference on 18 May 1920 was to discuss a "banking situation" with actual bankers, i.e. the class A directors of Federal Reserve Banks (Federal Reserve Board, 1923, p.2). In his introductory statement, Federal Reserve Board Governor Harding stressed the strong expansion of member bank loan portfolios by 25% between 1 April 1919 and 1 April 1920, over a time period when all indices of major production goods (grain, live stock, wool, copper, cotton, petroleum, pig iron, steel bars) had been falling on average by 10% (Federal Reserve Board, 1923, p.3).[16] Harding also emphasized that the usual contraction of loan portfolios in early spring remained absent in 1920, only a part of which could be explained by transportation bottlenecks (Federal Reserve Board, 1923, p.5). The Board Governor concluded that only proper policy action could stop speculative overborrowing: "When [a banker] understands that limitations and penalties may be imposed upon his borrowings, then if I know anything about the psychology of banking, I know that the banker may be depended upon to use a wiser discretion in the matter of granting credit" (Federal Reserve Board, 1923, p.8). When testifying before the Joint Commission of Agricultural Inquiry[17] in defense of the rate hike to 7%, Benjamin Strong, Governor of the Federal Reserve Bank of New York, explained that it was "the expansion of the loan account in which we were interested, and

[15] Class A directors of regional Reserve Banks were themselves directors of member banks.

[16] Complementary numbers on the financial developments during the boom months were summarized by the Joint Commission of Agricultural Enquiry (1922, p.42): "Between March 1919 and June 1920, national bank loans and discounts rose by 35%, loans and discounts made by the Federal Reserve System rose by 33% and Federal Reserve notes outstanding increased by 24%."

[17] The Joint Commission of Agricultural Inquiry was set up by Congress to investigate the causes of the ensuing agricultural crisis in 1920 and 1921.

Table 1: Situation of Federal Reserve Banks and their policy stance on 18 May 1920

District	**Situation**	**In favor of policy rate hike?**	**Policy eventually pursued**
District 1 Boston	District in very fortunate position, at top of the reserve list; no need to take drastic measures	No	LAW
District 2 New York	Large banks are overborrowing, further expansion must be prevented; increase rate to warn banks to not expand, aim: forestall serious disturbance in fall	Yes	LAW
District 3 Philadelphia	District not worried about credit situation; strongly disagrees with increase to 7%, also because of 6% legal rate	No	No policy
District 4 Cleveland	District never close to legal reserve limit, not necessary to increase rates	No (but if deemed best for country as whole willing to increase)	No policy
District 5 Richmond	District very comfortable at the moment, against increases in interest rates	No	No policy
District 6 Atlanta	District is generally well off, but some banks borrowing excessively; thinking about PDR as a remedy, but against rate hike	No (but might have to hike if NY does so)	PDR
District 7 Chicago	Moral suasion very ineffective; overborrowing is happening, happy to increase rate if necessary	Yes	LAW
District 8 St. Louis	District bears biggest burden of credit expansion, but against rate increase because of 6% limit	No	PDR
District 9 Minneapolis	Strong credit expansion because of needs of farmers; district against increase in rates and PDR, would cause too much hardship; resentment against Wall Street and finance	No	LAW
District 10 Kansas City	Strong overborrowing by some banks in big cities; first district on PDR, works very well and improved situation	Indifferent (high maximum penalty important)	PDR
District 11 Dallas	District against rate hike, increase would only be passed on to customers, will not end speculation, but add to burden of already high cost of living	No	PDR
District 12 San Francisco	District against rate hike and PDR, does not leave enough room for discretion; character, not amount of opposition matters	No (although one director favors increase)	No policy

Source: Federal Reserve Board (1923)

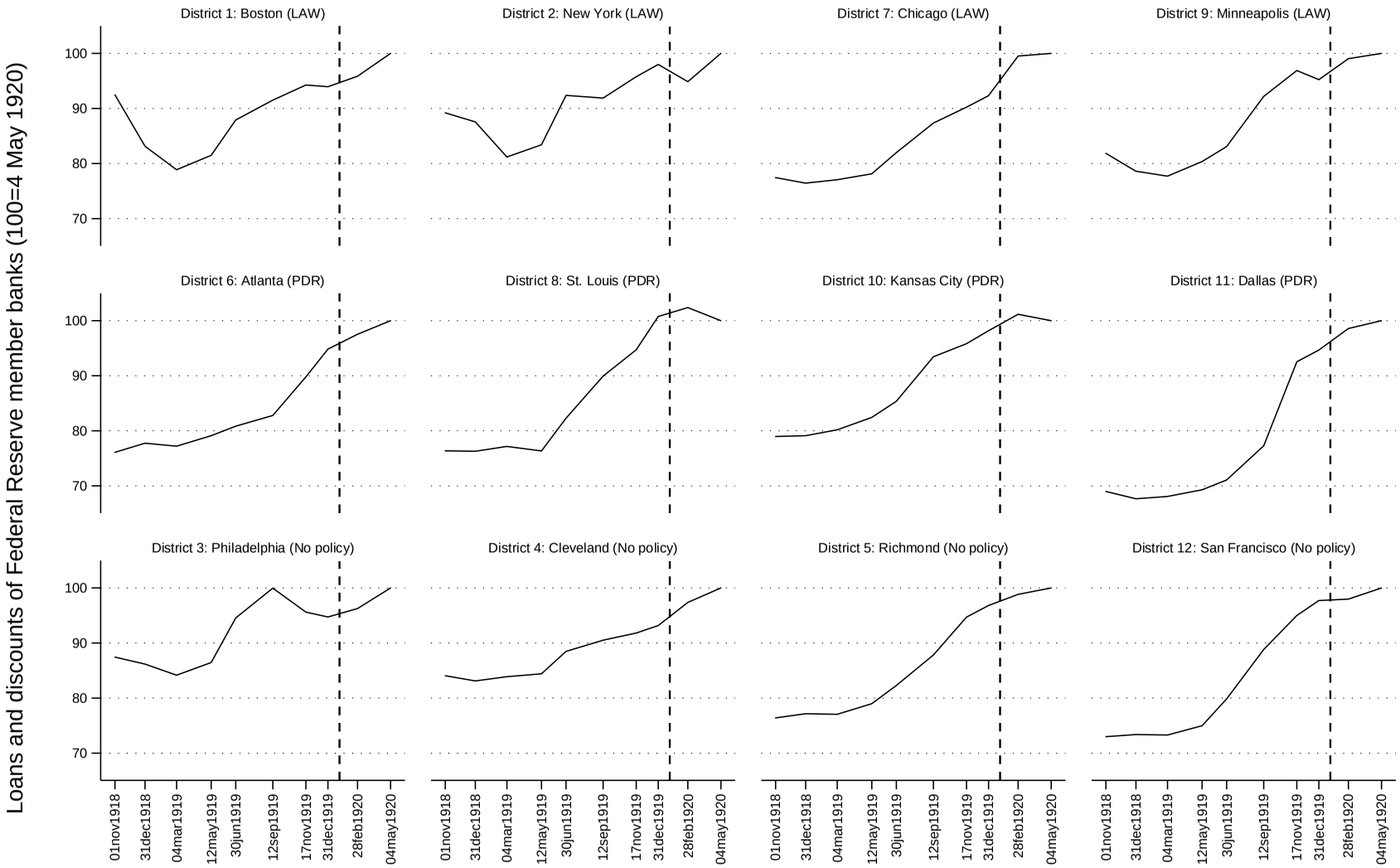
toward which we directed our rate" (quoted in Wicker, 1966, p.232). In its annual report for 1920, the Federal Reserve Bank of Boston (1920, p.16-17) in turn noted that the rates it had established on 23 January 1920 were "effective in reducing loans secured by government securities, but were not effective in controlling loans for commercial purposes and these continued to expand [...]. Loans were expanded in many cases fare beyond the limits of safety which the amount of capital invested in industries warranted. [...] A second general increase in rates was therefore put into effect on June 4, at which time commercial paper rates were advanced to 7 per cent [...]."

The final report of the Joint Commission of Agricultural Enquiry (1922) explains why credit expansion fueled acute financial stability concerns within the System. In its section on the role of credit based on testimonies by Federal Reserve officials active during this period, the report noted that Federal Reserve Banks' policy aim was that "credit for nonessential and speculative purposes would be limited as much as possible, and that the banks were not allowed to extend themselves so that failure would precipitate a financial crash" (Joint Commission of Agricultural Enquiry, 1922, p.51). According to the Joint Commission of Agricultural Enquiry (1922, p.51-52), the Board's and some of the Federal Reserve Banks' main preoccupation was "the preservation of the integrity of the banking system and the prevention of a financial panic". The authorities' thinking was that too accommodative a policy would induce banks to continue to expand loans at a time when prices had started to fall, putting strain on their solvency if debtors' ability to repay loans were to dwindle (Joint Commission of Agricultural Enquiry, 1922, p.88). The Joint Commission of Agricultural Enquiry (1922, p.87) explicitly mentioned the gradual erosion of safety buffers for depositors. Between September 1915 and September 1920, the ratio of paid-up capital to individual deposits of national banks had increased from 1:6.3 to 1:10.9, reducing safety buffers for depositors by around 42% over this period (Office of the Comptroller of the Currency, 1921a, p.207). This ratio peaked between September 1919 and September 1920, with deposits amounting to more than 11 times the paid-up capital. Once additional safety buffers (surplus and undivided profits) are included in total bank equity, the trends are less pronounced but still show a 60% increase in the deposits to capital ratio (from 1:3.23 in 1915 to 1:5.19 in 1920). Overall leverage, as measured by the ratio of total assets to paid-up capital, also peaked between these two dates. The aggregate ratio stood at 19:1 in September 1919, after having grown by 16% over the preceding twelve months (Ibid.). Thus, given the interplay of credit expansion and asset as well as commodity price increases at the time, "ordinary prudence dictated plainly that not only should speculation in corporate stocks and securities be restricted but that further expansion of banking credits made against goods and commodities in storage should be checked" (Federal Reserve Board, 1921, p.12).

The PDR enacted by the Federal Reserve Bank of Atlanta, St. Louis, Kansas City and Dallas PDR also targeted financial stability concerns but responded to the particular conditions prevailing in these districts. In contrast to Reserve Banks which subsequently opted for a rate hike, PDR districts observed large differences in the situation of individual member banks. "Some banks were greatly extended and borrowing heavily at the Federal Reserve Bank, in some instances as high as 10 or 15 times the basic line. Some banks were only slightly extended, borrowing moderately from the Federal Reserve Bank. Other banks were not extended at

all, and were not borrowing from the Federal Reserve Bank in any amount" (Joint Commission of Agricultural Enquiry, 1922, p.53). Hence, one major rationale for adopting the macroprudential tool of progressive rates was to distribute Federal Reserve Bank credit more evenly among the member banks in the PDR districts (Goldenweiser, 1925, p.42). The PDR did not penalize borrowing in general but only borrowing in excess of the basic line. Given the direct link between bank loans and reserve requirements (c.f. Section 3.1 in the main paper), borrowing in excess of the basic line represented the very definition of what Federal Reserve Banks considered "excessive credit expansion". Consequently, the PDR constituted a targeted macroprudential tool used by some Federal Reserve Banks to dampen excessive credit growth fueled by some subgroups of member banks only.

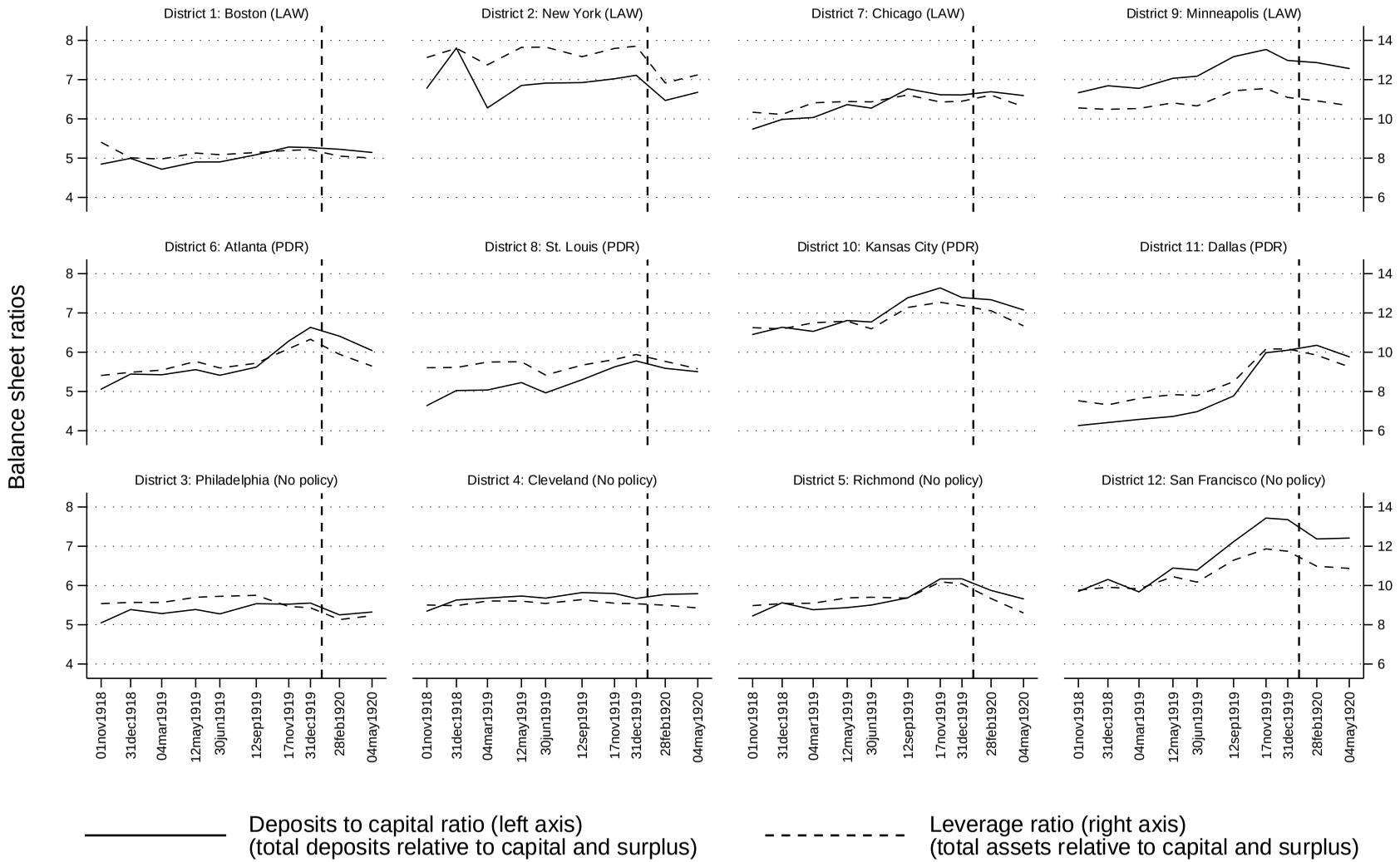
Figure 4: Federal Reserve member banks: loans and discounts (November 1918 - May 1920)



Source: Annual Report of the Federal Reserve Board (1920)

Vertical line corresponds to 23 January 1920.

Figure 5: Federal Reserve member banks: balance sheet ratios (November 1918 - May 1920)



Source: Annual Report of the Federal Reserve Board (1920)

Vertical line corresponds to 23 January 1920.

If financial stability concerns can explain differential Federal Reserve Bank policies in late spring 1920, one would expect the various districts to have experienced differential financial developments. Policy reactions should have been endogenous, reacting to different levels of financial strain in the districts. Figure 4 depicts the evolution of loan portfolios (indexed to 4 May 1920=100). The graph is organized in three rows, each corresponding to a Federal Reserve Bank policy stance (LAW, PDR, no policy - in that order, from top to bottom). It shows that loan portfolios grew substantially (between 10% and 30%) in all districts between summer 1919 and late spring 1920. Previous loan growth alone therefore does not provide a well-identified rationale for policy decisions.

The evolution of balance sheet ratios, which were stressed in the qualitative sources cited above, provides a clearer picture. Figure 5 summarizes the changes over time in the level of the deposits to capital ratio and the leverage ratio for all Federal Reserve member banks in the twelve districts. Arranged in the same way as Figure 4, Figure 5 conveys two main insights. First, it shows that, on average, both ratios were most elevated in districts which hiked the discount rate to 7%, whereas the average non-policy district displays both low levels of leverage and mostly flat developments in the ratios. Second, Figure 5 suggests that the Boston and the San Francisco district experienced levels/trends which were drastically different from those of its policy peers. The Boston district was characterized by remarkably low levels of leverage and deposits relative to capital and surplus, whereas district 12 displayed much stronger upward trends in both ratios in comparison to its non-policy peer districts. Hence, the financial developments in the Boston and San Francisco districts were at odds with the policy response adopted in these districts. This disconnect seems particularly puzzling in the case of the Federal Reserve Bank of Boston which had explicitly justified its rate hike by a desire to curb loan growth and safeguard financial stability (c.f. quote above). One possibility is that the Boston Reserve Bank merely rationalized its response as one driven by financial stability concerns, while it really only reacted to spill-over pressure emanating from the decision taken in the financial centers of Chicago, and particularly, New York. The chronology of policy decisions shown in Table 1 of the main paper would allow for this possibility, given that Boston only moved to hike its rate four days after the three other Federal Reserve Banks which increased the commercial paper rate to 7%. In addition to the arguments mentioned in Section 2 of the main paper, the special environment prevailing in districts 1 and 12 provides another good reason to exclude them from the empirical analysis in this paper.

PDR districts represented "middle ground" relative to the other two policy stances. On the one hand, according to Figure 5, PDR districts experienced the most homogeneous upward trend in financial ratios in the period between summer 1919 and the uniform rate hike in January 1920. On the other hand, qualitative sources discussing the PDR argued that the aggregate numbers for districts 6, 8, 10 and 11 masked a skewed distribution of bank-level leverage as the main rationale for the adoption of financial stability policies. In order to investigate whether unequal trends at the bank-level can effectively explain the adoption of the macroprudential tool, I compute Gini coefficients for the bank-level leverage ratio and the deposits to capital ratio based on my data sample covering national banks from the following 17 states: Alabama, Delaware, District of Columbia, Georgia,

Table 2: Gini coefficients and pairwise mean equality tests for balance sheet ratios (Jan 1920)

Variable	LAW districts Gini coefficient	PDR districts Gini coefficient	No policy districts Gini coefficient
Deposits to capital ratio	0.21 (0.03)	0.26 (0.02)	0.23 (0.015)
Leverage ratio	0.17 (0.03)	0.25 (0.02)	0.21 (0.02)

Deposits to capital ratio	LAW districts	vs. PDR districts	t-stat =1.15
T-tests	LAW districts	vs. No policy districts	t-stat =0.81
	PDR districts	vs. No policy districts	t-stat =1.41
Leverage ratio	LAW districts	vs. PDR districts	t-stat =1.75*
T-tests	LAW districts	vs. No policy districts	t-stat =1.43
	PDR districts	vs. No policy districts	t-stat =0.97

Jackknife standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Source: Rand McNally bankers directory (1920); own calculations

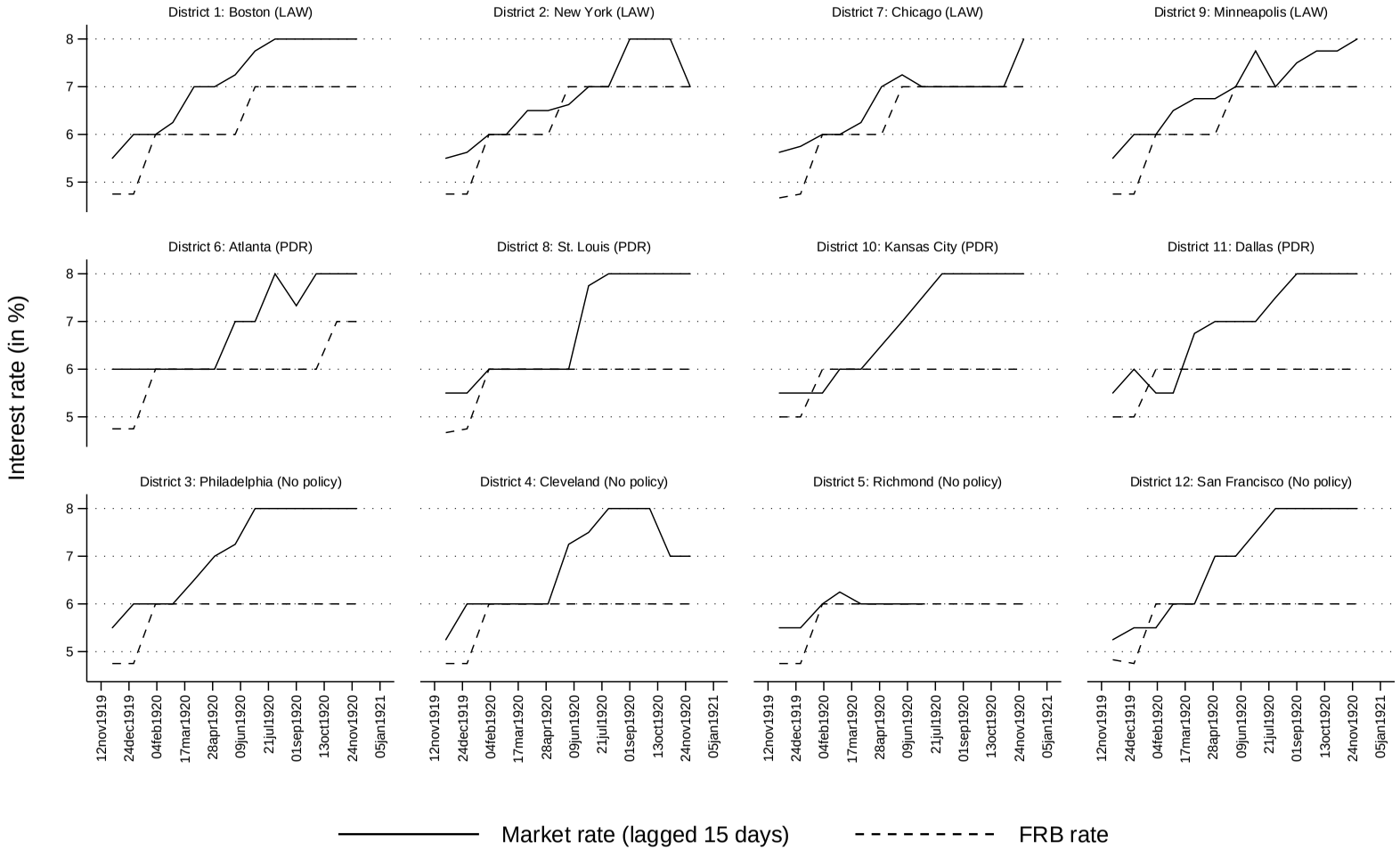
Indiana, Kentucky, Maryland, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia. Table 2 summarizes the results for all three policy types. A clear hierarchy emerges from Table 2. Prior to the policy reaction, districts which later adopted the PDR had indeed experienced the most skewed distribution of financial ratios. PDR districts were characterized by higher Gini coefficients for bank-level leverage and deposits to capital ratios than LAW and no-policy districts. To test whether the Gini coefficients for the three policy groups can be statistically distinguished from each other, I use jackknife methods to compute standard errors for the Gini estimates. While the test statistics cannot reject the null of equality in most cases, districts which adopted the PDR do seem to have experienced a statistically more skewed leverage distribution than LAW districts prior to June 1920. One plausible reason why I am not be able to reject the equality of Gini coefficients more generally may be that my bank-level sample does not cover the states which showed the most skewed distributions of bank-level leverage and deposit to capital ratios. Qualitative evidence from the Joint Commission of Agricultural Enquiry (1922) and Wallace (1956) suggests that Colorado, Kansas, Missouri, and Nebraska were home to those national banks which borrowed most extensively above their basic line. Unfortunately, none of these states is covered in my bank-level panel data set. Overall, bank-level data tentatively confirms that the adoption of a macroprudential tool in some Federal Reserve districts followed a logical rationale: although the situation of the average bank may have not warranted a general rate increase, the exposure of several individual banks constituted the main concern for policymakers.

Ruling out alternative explanations for policy differences

Can alternative explanations for the second wave of monetary tightening be definitely excluded? First, Figure 3 provides some relevant insights with regard to the gold reserve policy rule. In only one of the districts which hiked the rate to 7% (Minneapolis) was the reserve ratio (before accommodation) clearly experiencing

a downward trend and stood below 40% at the time when the hike was enacted. In all three other cases, the reserve was either above the threshold and rising (New York and Boston) or slightly below the legal ratio but stagnant (Chicago). Furthermore, three of the four districts which did not implement any policy changes after January 1920 (Richmond, Philadelphia and San Francisco) had reserve ratios and/or trends in the reserve position strikingly similar to districts which hiked the commercial paper rate to 7%. Had reserve ratios been the main determinant of rate policy in June 1920, other districts should have also reacted. According to Figure 3, the distinctive feature of the four PDR districts appears to be a strong downward trend of reserve ratios in the months and weeks before the policy was adopted – although only St Louis had a substantial reserve deficit. It remains unclear, however, why the Federal Reserve Banks of Atlanta, Dallas, Kansas City and St Louis would go all the way to adopt the sophisticated macroprudential tool of progressive discount rates if the aim was merely to protect their reserve positions. To consolidate the reserve ratio, a rate hike to 7% would have represented a much more straightforward option.

Figure 6: Market rates and Federal Reserve Banks' (FRB) discount rates for commercial paper (November 1919 - December 1920)



Source: Federal Reserve Bulletin (various issues)

* No market rates available for district 5 after 1 July 1920.

Second, at first sight, the annual reports of three of the four Federal Reserve Banks which adopted 7% rates suggest considerations related to the policy rule derived from the real bills doctrine might have played a role in spring 1920. According to the Federal Reserve Bank of Boston (1920, p.16), the 6% rate established in January was "not only not equal to, but rather below the outside market rate". Thus, this spread might have constituted a rationale for a further, rules-based rate increase in June 1920. Similarly, in its annual report to the Board, the New York Fed noted that its rate hike to 7% had also been taken "in order that bankers, their customers, and the public generally may find the discount rates of this bank a reflection of existing credit conditions" (Federal Reserve Board, 1921, p.381). The Federal Reserve Bank of Minneapolis (1920, p.10) equally argued that its rate increases in 1920 reflected "the changes which took place in local market interest rates during the year." To investigate whether a systematic policy rule was at work, Figure 6 compares Federal Reserve Bank discount rates and market rates (lagged by 15 days) for commercial paper between November 1919 and December 1920. Figure 6 indeed illustrates a positive correlation between official discount rates and lagged market rates. Yet, the fit is far from perfect. If the tracking of market rates represented a primary policy rule, then even the Federal Reserve Banks which hiked rates to 7% only partially followed this rule: both, hikes to 8% and much earlier increases in discount rates would have been required to really shadow market rates in 1920. Furthermore, given the strong rise of market rates in all districts in 1920, Federal Reserve Banks which did not implement rate changes in late spring (Philadelphia, Cleveland, and San Francisco)[18] clearly violated the policy rule. Finally, the very implementation of the PDR in some districts would seem inconsistent with the real bills view: on the one hand, there is no reason why some banks should not borrow (much) more from their Reserve Bank than their peers as long as the right material is presented for rediscount; on the other hand, under the PDR only some banks faced discount rates equal (or above) market rates, while a large part of borrowing was done at far below market rates (c.f. the spread between market and discount rates in the Atlanta, Dallas, Kansas City, St Louis districts shown in Figure 6). Hence, overall the real bills doctrine had, at best, a subordinated role to play in 1920 when it came to policy rate decisions.

A final alternative explanation for differential policy decisions is suggested by some of the remarks recorded in Table 1. During the Federal Reserve Board conference on 18 May 1920, class A directors of the Federal Reserve Districts of Philadelphia and St Louis explained their opposition to increasing policy rates to 7% with reference to state-specific usury laws. As pointed out by Ryan (1924, p.18), Federal Reserve Banks were not subject to state usury laws but national banks had to abide by these regulations. Whenever Federal Reserve Banks set official rates above the statutory maximum for interest rates in a state within its district, member banks located in that state could not pass on the increased refinancing costs to borrowers. To avoid this situation, which harbored the potential for conflict with their member banks, some districts may have refrained from raising interest rates and/or resorted to the PDR instead. In particular, Ryan (1924, p.20) mentions that member bank opposition to a rate hike in the Philadelphia district may explain why the third district did not raise its rediscount rate in 1920. In order to investigate potential systematic relationships between state usury

[18] Unfortunately, for district 5 no market rate data is available after 1 July 1920.

Table 3: Usury rates in the United States, summarized by Federal Reserve district (1921)

District	Statutory maximum for interest rates	Average maximum rate	Smallest maximum rate	Policy adopted
District 1 Boston	Connecticut: 6 Maine: N/A Massachusetts: N/A New Hampshire: N/A Rhode Island: 30 Vermont: 6	14*	6	LAW
District 2 New York	Connecticut: 6 New Jersey: 6 New York: 6	6	6	LAW
District 3 Philadelphia	Delaware: 6 New Jersey: 6 Pennsylvania: 6	6	6	No policy
District 4 Cleveland	Kentucky: 6 Ohio: 8 Pennsylvania: 6 West Virginia: 6	6.5	6	No policy
District 5 Richmond	District of Columbia: 10 Maryland: 6 North Carolina: 6 South Carolina: 8 Virginia: 6 West Virginia: 6	7	6	No policy
District 6 Atlanta	Alabama: 8 Florida: 10 Georgia: 8 Louisiana: 8 Mississippi: 8 Tennessee: 6	8	6	PDR
District 7 Chicago	Illinois: 7 Indiana: 8 Iowa: 8 Michigan: 7 Wisconsin: 10	8	7	LAW
District 8 St Louis	Arkansas: 10 Illinois: 7 Indiana: 8 Kentucky: 6 Mississippi: 8 Missouri: 8 Tennessee: 6	7.6	6	PDR
District 9 Minneapolis	Michigan: 7 Minnesota: 10 Montana: 12 North Dakota: 10 South Dakota: 12 Wisconsin: 10	10.2	7	LAW
District 10 Kansas City	Colorado: N/A Kansas: 10 Missouri: 8 Nebraska: 10 New Mexico: 12 Oklahoma: 10 Wyoming: 12	10.3*	8	PDR
District 11 Dallas	Arizona: 10 Louisiana: 8 New Mexico: 12 Texas: 10	10	8	PDR
District 12 San Francisco	Alaska: 12 Arizona: 10 California: 12 Idaho: 10 Nevada: N/A Oregon: 10 Utah: 12 Washington: 12	11.1*	10	No policy

Policy	Number of states with legal maximum	Average maximum rate	Standard deviation (avg. max. rate)	Average smallest maximum rate
No policy districts:	20	8.2	2.5	7
LAW-rate districts:	17	9.5 (8.2ˆ)	5.7 (2.2ˆ)	6.5
LAW-PDR districts:	23	8.8	1.8	7

Source: Ryan (1924); own calculations.
Some districts cut through states. Consequently, some states appear more than once in the table above.
* Only states with legal limits taken into account. N/A indicates states without legal limits.
ˆ Excluding Rhode Island.

laws and monetary policy in the different districts, Table 3 summarizes data on statutory maximum rates in the 12 districts. Table 3 reports substantial variation in the average maximum rate and slightly less variation for the smallest maximum rate across Federal Reserve districts. The smallest maximum rate allowed within a district was on average higher in PDR districts and districts without policy than in districts which hiked rates to 7% (c.f. end of Table 3, rightmost column). Furthermore, mean equality tests of statutory maximum rates comparing the three policy regimes are very far from rejecting the null of equality in any of the pairwise comparisons.[19] Comparisons of neighboring states/districts on a case-by-case basis confirm that policy differences are hard to explain away simply by differences in state usury laws. For example, the districts of New York and Philadelphia had the exact same level of average legal rates and smallest maximum rates allowed; yet, the former hiked rates, whereas the latter did not. Equally, the Kansas City district would have had more leeway to increase rates than the Federal Reserve Bank of Minneapolis and still the former opted for the PDR whereas the latter hiked rates. Finally, San Francisco benefited from one of the highest levels of flexibility in the System according to state usury law, but refrained from increasing rates. Overall, state-specific usury laws within a given district are imperfect predictors of district-level variation in monetary policies.

Appendix A.3: Further details on the U.S. banking landscape

The bank-level balance sheet data used in this study is drawn exclusively from one particular subgroup of U.S. financial institutions, so called national banks. The historical context explains this choice. Before the founding of the Federal Reserve System in 1914, the U.S. banking sector knew two broad classes of banks: state-chartered credit institutions and national banks. Whereas the former were regulated according to different laws from state to state and cannot be easily compared to each other across states, the latter constituted a group of banks subject to a single regulatory framework at the federal level. Moreover, state banks were supervised by their state's Banking Department, providing ample room for regulatory "home bias". In contrast, the stipulations of the National Banking Act of 1863 created a level-playing field for all financial institutions chartered as national banks.[20] Chartering and supervision of national banks was (and still is) administered by the Office of the Comptroller of the Currency (OCC), which functions as an independent bureau of the U.S. Department of the Treasury.[21]

After the foundation of the Federal Reserve System, another dichotomy of bank types was superimposed on the pre-existing structure. After 1914, all national banks had to join the Federal Reserve System. State banks, however, could choose to become member banks of the Federal Reserve System or remain outside the System. The benefits of joining the System included first and foremost the right to borrow from the Federal Reserve to weather a systemic liquidity crisis or to satisfy idiosyncratic liquidity needs. The "flip side" of membership

[19] These results do not change if one excludes Rhode Island which was a clear outlier at the time with a maximum rate of 30%.

[20] One exception from this rule relates to differences in state-level usury laws which also applied to national banks. I discuss in detail why these differences do not invalidate my research design in section 5 of the main paper.

[21] Apart from State Banking Departments and the OCC, no other authorities were directly involved in the supervision of state banks and national banks prior to 1914. Today's primary supervisor of state-chartered banks, the Federal Deposit Insurance Corporation (FDIC), was only founded in 1933.

consisted of additional direct supervision by the Federal Reserve System and the obligation to abide by specific reserve requirements for deposit liabilities. Member banks had to maintain liquid reserves amounting to 3% of their time deposits plus 7% of their demand deposits. In reserve cities (cities with Federal Reserve Bank branches) and central reserve cities (cities in which the regional Federal Reserve Banks were located), member banks needed to fulfill higher reserve requirements for demand deposits (10% and 13% respectively). Required reserves needed to be maintained exclusively with the Federal Reserve System, in the form of deposit accounts.[22] A deficient reserve position could result from an increase in deposits (due to an actual increase of deposited cash or by way of deposit creation) or from large-scale withdrawals of deposits which exceeded banks' own cash reserves and thus forced them to tap into their required reserves maintained with the Federal Reserve System. In order to correct a deficient reserve position, member banks borrowed from the System, an operation which resulted in crediting banks' deposit account with the Federal Reserve.

Appendix A.4: Moral suasion

Moral suasion, also known as "direct action", describes attempts by Federal Reserve Banks to prevent further loan expansion by formally or informally communicating their opinion on acceptable levels of credit growth to banks in their district. Moral suasion does not involve any explicit policy measures that would affect nominal interest rates. If practiced during the period when LAW and macroprudential policies were effective, moral suasion could have biased estimated treatment coefficients. On the one hand, if direct action was only or mostly pursued by Federal Reserve Banks which did not change their policy stance in late spring 1920, moral suasion could have biased treatment effects towards zero. In order to produce a downward bias, however, direct action must have been effective. The final report of the Joint Commission of Agricultural Enquiry (1922, p.41-42) notes that moral suasion was indeed a widespread practice during the period immediately preceding expansion, between the end of World War I and spring 1919. During this period, Federal Reserve Banks sent out letters and circulars admonishing member banks to confine loans to essential requirements, rather than speculative or non-essential purposes. The ensuing boom suggests these attempts remained quite unsuccessful – although, of course, no appropriate counter-factual scenario exists. Furthermore, in contrast to LAW and PDR districts, the less pronounced financial expansion in non-policy districts provided hardly any incentives to engage in direct action in the first place.

On the other hand, if moral suasion was mostly prevalent in Federal Reserve districts which implemented LAW or the PDR, it may have biased the treatment effects away from zero. In this scenario, direct action might have amplified the impact of explicit financial stability policies. Indeed, the only relevant circular addressed to member banks I could find for the time span of interest to this study was issued by the Federal Reserve Bank of St Louis.[23] In this circular, the Reserve Bank complained about the fact that member banks passed on

[22] The full centralization of required reserves by the Federal Reserve System was introduced by an early amendment to the Federal Reserve Act in June 1917.

[23] The circular can be read here: FRASER, Circular Federal Reserve Bank of St Louis; last accessed 22 July 2020.

the higher policy rates to their customers. Hence, the Federal Reserve Bank asked member banks to stop this practice. The circular may have led member banks to exercise more restraint when granting new loans, but it did not contain an explicit request to do so. Overall, it is difficult to exactly determine whether my estimated treatment effects are biased by moral suasion attempts in 1920 and 1921. Under the assumption that direct action was pursued by all Federal Reserve Banks at least to some extent, the different biases might have also canceled each other out.

Appendix A.5: Monetary policy decentralization

In my paper, I exploit the decentralized nature of U.S. monetary policy-making which characterized the Federal Reserve System before 1935. Since its foundation in 1914 until today, the Federal Reserve System is composed of twelve regional Federal Reserve Banks with their twelve corresponding Federal Reserve districts and the Federal Reserve Board located in Washington D.C. Prior to the Banking Act of 1935, the twelve Federal Reserve Banks had the legal right to maintain monetary policy stances, including policy rate schedules, which differed from each other as long as these differences were formally approved by the Board in the capital. Throughout the period between 1918 and 1935, the Board used its statutory right to enforce a discount rate different from the one proposed by a regional Federal Reserve Bank on only two occasions.[24] The reluctance on the part of the Board to enforce uniform monetary policy stances led to several episodes with marked spreads in nominal policy rates across regions (Cohen-Setton, 2016). These regional policy differences could be meaningfully maintained inside the U.S. monetary union only because of financial segmentation.

The decentralized system of U.S. monetary policy-making before 1935 raises two questions relevant to the research design of my paper. The first one is contextual: why was the Federal Reserve System decentralized in the first place? On the one hand, the founding fathers of the Federal Reserve Act considered decentralization necessary because the seasonal demand for money varied substantially from region to region depending on whether the primary, secondary or tertiary sector dominated the local economy (Jaremski and Wheelock, 2017). It was opined that a single monetary policy would not be well suited to cater for different regional demand functions of high-powered money. This historical rationale for decentralization again suggests that it is important to employ an estimation strategy which is unaffected by the potentially large regional differences in economic structure. For this reason, I draw on local discontinuity regressions within small bandwidths around the Federal Reserve district borders.

On the other hand, it is important to understand that the Federal Reserve System was superimposed upon a pre-existing interbank market structure known as the "pyramid system". Long prior to the establishment of the Federal Reserve, national banks had created a network of interbank relationships (so called "correspondents") which spanned the entire territory of the United States. The pyramid system separated banks into three

[24] One of these occasions occurred in January 1920. I discuss this episode in Appendix A.2 above. The second dissenting Board opinion was issued in September 1927 (Cohen-Setton, 2016, p.18). During the first World War, the Federal Reserve System operated as a quasi-agency of the U.S. Treasury (Meltzer, 2003).

different layers according to their location. From bottom to top, these layers were composed of country banks, banks located in larger cities and banks in financial centers like New York known as reserve cities. Banks at the lower ends of the pyramid maintained correspondent relationships with those in larger cities and reserve cities for two reasons. First, they had an incentive to keep correspondents in larger cities to collect and make payments on financial obligation involving distant locations. Second, the National Bank Act authorized banks to maintain some of their required reserves as deposits in designated reserve cities.[25] Since these interbank deposits were remunerated, correspondent links represented an attractive alternative to holding reserves simply in the form of cash in bank vaults. The problematic feature of the "pyramid system" was that it readily transmitted liquidity shocks from financial centers to the hinterland and vice versa (Mitchener and Richardson, 2013, 2019). Hence, the second rationale for the decentralized nature of the Federal Reserve System was to break up the concentration of bank reserves in large financial centers and lessen the dependence of small banks on the interbank market (Jaremski and Wheelock, 2017).

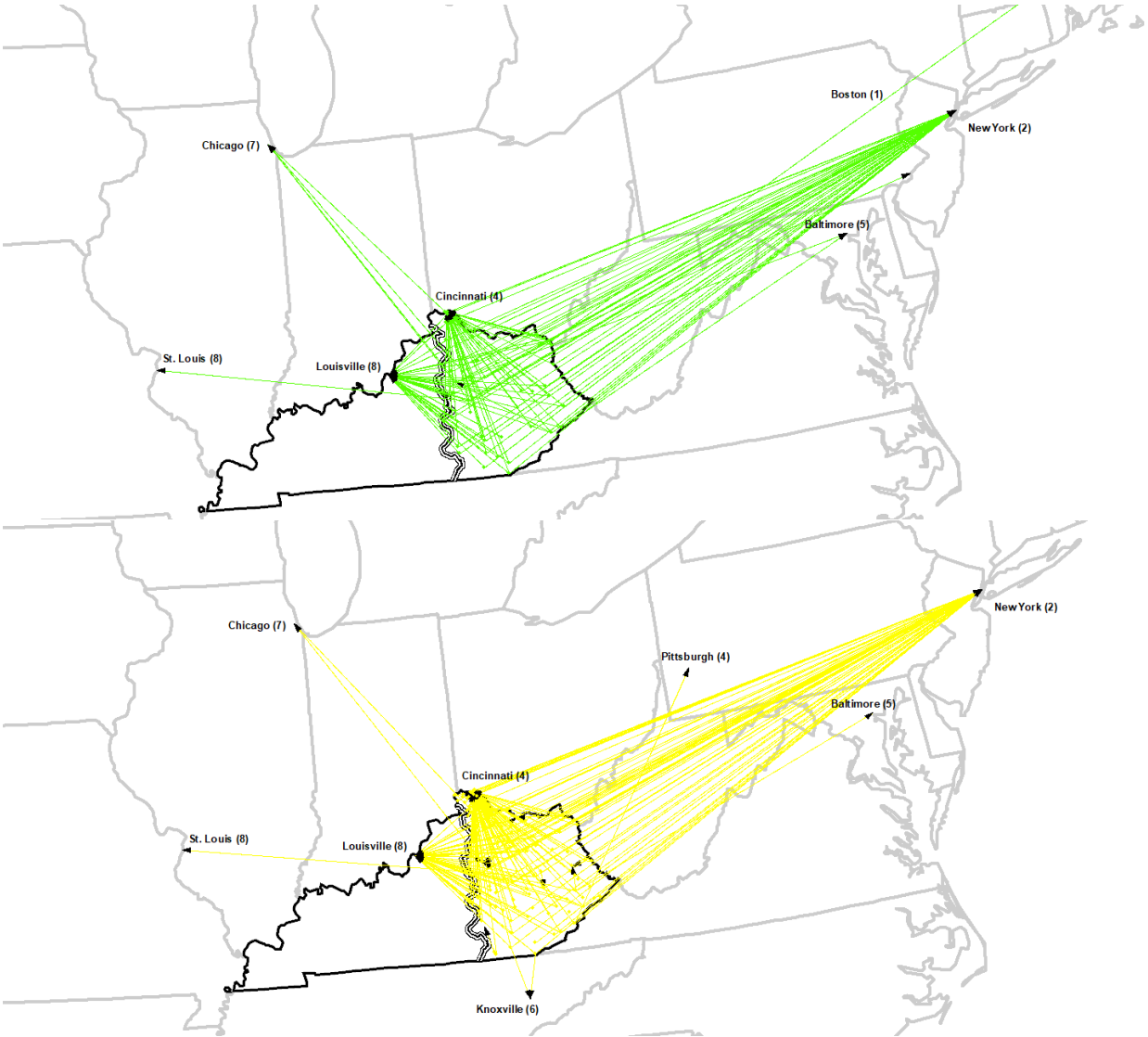
The second question concerns the placement of Federal Reserve district borders. As shown in Figure 1 of the main paper, Federal Reserve district borders did not always coincide with state borders. How did the Federal Reserve System decide where exactly to draw borders between its constituent twelve districts? Jaremski and Wheelock (2017) show that the district borders reflected the preferences of national banks and, in particular, the correspondent relationships of national banks. The Federal Reserve System superposed its district structure mainly on pre-existing interbank networks and pooled, as much as possible, those national banks into one single district which had already developed strong commercial ties prior to 1914. The System's approach to border design thus strengthens my identification strategy as it ring-fenced large parts of the U.S. interbank network into separate Federal Reserve districts. In order to complement the evidence provided by Figures 7 and 8 in the main paper, Figures 7 and 8

Appendix A.6: Sorting tests

In regression discontinuity settings, units must not have precise control over their assignment into treatment and control groups (Lee and Lemieux, 2010, p.292). Imperfect control over assignment is a precondition for interpreting an observational setting as a locally randomized quasi-experiment. In the context of this study, sorting would take the form of banks relocating from a Federal Reserve district following LAW or macroprudential policies to a district without policy changes in late spring 1920. Relocation could happen in anticipation of differential policies and/or after policies have entered into force. To rule out any type of anticipatory relocation, manipulation tests à la McCrary (2008) could be applied to check the cross-sectional density distribution of units around the cut-off. Note, however, that a simple discontinuity in the density of unit locations around the district borders is not a proof of sorting in the context of this study. Given the paper's geographic setting, such discontinuities might simply reflect geographic or topographic differences which might or might not be econom-

[25] This point refers to the reserve requirements in place prior to the establishment of the Federal Reserve System.

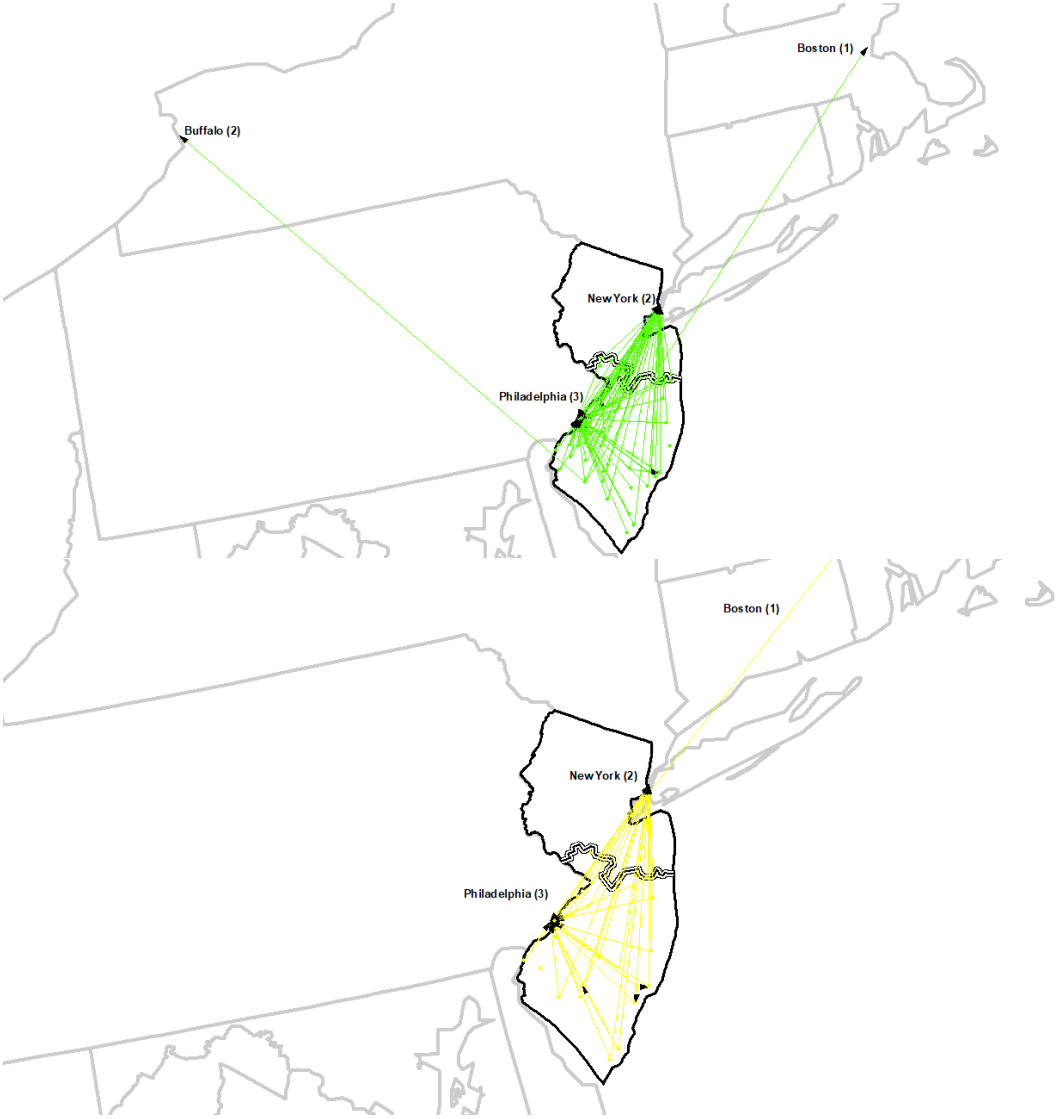
Figure 7: Interbank links of banks in the split state of Kentucky (district 4)



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

* This graph plots the interbank links of all commercial banks located in the untreated half in the split state of Kentucky. The upper panel shows the outgoing correspondent links of Federal Reserve member banks (green lines). The lower panel shows the outgoing correspondent links of non-member banks (yellow lines). The names of the most important correspondent cities are indicated on the map (including the number of the district in which the city is located).

Figure 8: Interbank links of banks in the split state of New Jersey (district 3)



Source: Rand McNally bankers directory (1920); OpenCage Geocoder

* This graph plots the interbank links of all commercial banks located in the untreated half in the split state of New Jersey. The upper panel shows the outgoing correspondent links of Federal Reserve member banks (green lines). The lower panel shows the outgoing correspondent links of non-member banks (yellow lines). The names of the most important correspondent cities are indicated on the map (including the number of the district in which the city is located).

ically meaningful. Furthermore, cross-sectional manipulation analysis alone does not provide a convincing test of the absence of assignment manipulation for another reason: the research design of this paper also involves a time component.

In order to check for sorting, I therefore test the equality of distributions of banks around district borders at different moments in time. The formal statistical tests complementing Figures 5 and 6 in the main paper are provided below. The Kolmogorov-Smirnov tests cannot reject the hypothesis that the distributions compared in Panels A, B and C are identical. In addition, McCrary density tests cannot reject the null of no geographic sorting around the border at any conventional confidence level. The distributions are all right-skewed, reflecting higher numbers of banks in the control groups. However, the distributions transition smoothly at the border and exhibit no statistically significant break in the densities. These test results provide strong evidence against the presence of treatment assignment manipulation by national banks at the Federal Reserve district borders.

Table 4: LAW borders - treatment assignment manipulation tests for national banks

Kolmogorov-Smirnov equality of distribution tests				
Call dates compared	Distance to border	Total N	Unique values	P-value*
Sep 1919 - Jan 1920	no restriction	5,307	1,907	1.00
Sep 1919 - Jan 1920	<200km	4,025	1,439	1.00
Sep 1919 - Jan 1920	<150km	3,244	1,181	1.00
Sep 1919 - Jan 1920	<100km	2,286	831	1.00
Sep 1919 - Jan 1920	<75km	1,773	640	1.00
Sep 1919 - Jan 1920	<50km	1,086	412	1.00
Sep 1919 - Jan 1920	<25km	524	200	1.00
Jan 1920 - Sep 1920	no restriction	5,383	1,904	1.00
Jan 1920 - Sep 1920	<200km	5,383	1,904	1.00
Jan 1920 - Sep 1920	<150km	3,291	1,180	1.00
Jan 1920 - Sep 1920	<100km	2,327	830	1.00
Jan 1920 - Sep 1920	<75km	1,803	640	1.00
Jan 1920 - Sep 1920	<50km	1,101	412	1.00
Jan 1920 - Sep 1920	<25km	527	200	1.00
Jan 1920 - Sep 1921	no restriction	5,368	1,914	1.00
Jan 1920 - Sep 1921	<200km	4,067	1,447	1.00
Jan 1920 - Sep 1921	<150km	3,286	1,188	1.00
Jan 1920 - Sep 1921	<100km	2,326	835	1.00
Jan 1920 - Sep 1921	<75km	1,800	644	1.00
Jan 1920 - Sep 1921	<50km	1,103	415	1.00
Jan 1920 - Sep 1921	<25km	529	203	1.00

McCrary density tests				
Call date	N control group	N treated group	Estimated BWs	P-value^
Sep 1919	1,746	870	69.8/65.1	0.67
Jan 1920	1,787	904	66.8/62.7	0.94
Sep 1920	1,788	904	67.0/62.6	0.96
Sep 1921	1,780	897	67.2/63.1	0.94

Source: Office of the Comptroller of the Currency (1920, 1921b, 1922); own calculations
* Combined Kolmogorov-Smirnov p-value (null hypothesis: equality of distributions).
^ P-value for robust bias-corrected test following Cattaneo et al. (2018); null hypothesis: no sorting.

LAW borders constitute Federal Reserve district borders separating districts which hiked the policy rate to 7% and districts which did not "lean against the wind". In this study, these district borders are the borders separating 1) district 4 (Cleveland) and district 7 (Chicago); 2) district 2 (New York) and district 3 (Philadelphia); 3) district 2 (New York) and district 4 (Cleveland).

Table 5: PDR borders - treatment assignment manipulation tests for national banks

Kolmogorov-Smirnov equality of distribution tests				
Call dates compared	Distance to border	Total N	Unique values	P-value*
Sep 1919 - Jan 1920	no restriction	2,585	923	1.00
Sep 1919 - Jan 1920	<200km	1,266	444	1.00
Sep 1919 - Jan 1920	<150km	948	338	1.00
Sep 1919 - Jan 1920	<100km	632	239	1.00
Sep 1919 - Jan 1920	<75km	459	173	1.00
Sep 1919 - Jan 1920	<50km	329	121	1.00
Sep 1919 - Jan 1920	<25km	129	52	1.00
Jan 1920 - Sep 1920	no restriction	2,618	921	1.00
Jan 1920 - Sep 1920	<200km	1,281	442	1.00
Jan 1920 - Sep 1920	<150km	960	335	1.00
Jan 1920 - Sep 1920	<100km	642	238	1.00
Jan 1920 - Sep 1920	<75km	465	171	1.00
Jan 1920 - Sep 1920	<50km	333	120	1.00
Jan 1920 - Sep 1920	<25km	131	52	1.00
Jan 1920 - Sep 1921	no restriction	2,626	938	1.00
Jan 1920 - Sep 1921	<200km	1,284	452	1.00
Jan 1920 - Sep 1921	<150km	967	345	1.00
Jan 1920 - Sep 1921	<100km	649	246	1.00
Jan 1920 - Sep 1921	<75km	470	177	1.00
Jan 1920 - Sep 1921	<50km	335	123	1.00
Jan 1920 - Sep 1921	<25km	132	53	1.00

McCrary density tests				
Call date	N control group	N treated group	Estimated BWs	P-value^
Sep 1919	869	411	378.9/263.0	0.15
Jan 1920	894	411	293.2/236.4	0.33
Sep 1920	897	416	302.4/225.7	0.35
Sep 1921	904	417	210.8/212.8	0.32

Source: Office of the Comptroller of the Currency (1920, 1921b, 1922); own calculations

* Combined Kolmogorov-Smirnov p-value (null hypothesis: equality of distributions).

^ P-value for robust bias-corrected test following Cattaneo et al. (2018); null hypothesis: no sorting.

PDR borders constitute Federal Reserve district borders separating districts which introduced the PDR scheme and districts which did not "lean against the wind". In this study, these district borders are the borders separating 1) district 4 (Cleveland) and district 8 (St Louis); 2) district 4 (New Cleveland) and district 6 (Atlanta); 3) district 5 (Richmond) and district 6 (Atlanta).

Appendix B: Additional baseline results

Appendix B.1: Summary statistics

Table 6: Summary statistics for full samples (including double counts in the control group)

Panel A. LAW borders

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
Total lending (ln)	10,589	13.7997	1.1682	8.2756	20.2982	13.6628
Leverage ratio (ln)	10,589	1.8337	0.4184	-2.0665	3.9188	1.8384
Cash reserves & exchange to deposits ratio	10,589	0.1890	0.2425	0.0000	22.2542	0.1653
Bank equity (ln)	10,589	11.966	1.1399	9.3674	18.5438	11.817

Panel B. PDR borders

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
Total lending (ln)	5,191	13.5563	1.089	8.2756	18.156	13.4588
Leverage ratio (ln)	5,191	1.7201	0.4056	-1.2511	3.7503	1.736
Cash reserves & exchange to deposits ratio	5,191	0.2226	0.3366	0.0222	22.2542	0.1954
Bank equity (ln)	5,191	11.8362	1.0328	9.3674	16.1749	11.7361

All variables as defined in Table 2 of the main paper.

Some banks appear in both Panel A and Panel B of Table 6 because they serve as control units for both the LAW policy and the PDR policy. The reason for their double appearance is that some control group districts share borders with both types of treated districts (e.g. district 4). Hence, the total sum of observations in Panel A and Panel B (almost 16,000) exceeds the number mentioned in the data section of the main paper (12,996). Table 7 below concentrates on observations located within the 200km radius around borders. The total number of observations in Table 7 is thus significantly lower, also because double counting happens less often.

Table 7: Summary statistics for 200km radius around borders

Panel A. LAW borders

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
Total lending (ln)	8,018	13.8792	1.2001	8.3405	20.2982	13.7355
Leverage ratio (ln)	8,018	1.8384	0.4264	-2.0665	3.7503	1.8411
Cash reserves & exchange to deposits ratio	8,018	0.1846	0.2667	0.0000	22.2542	0.1617
Bank equity (ln)	8,018	12.0409	1.1764	9.3674	18.5438	11.8921

Panel B. PDR borders

Variable	Obs	Mean	Std. Dev.	Min	Max	P50
Total lending (ln)	2,535	13.5374	1.0646	8.2756	17.651	13.415
Leverage ratio (ln)	2,535	1.7058	0.3922	-1.1579	3.7503	1.7079
Cash reserves & exchange to deposits ratio	2,535	0.2217	0.1444	0.0222	3.4286	0.1992
Bank equity (ln)	2,535	11.8316	1.032	9.4084	16.1749	11.7461

All variables as defined in Table 2 of the main paper.

Appendix B.2: Baseline results with control coefficients

Table 8: Treatment effects for LAW and PDR policy (including results for control variables)

Panel A. LAW borders

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.00	0.02	0.03	0.04	0.06	0.05
	[0.01]	[0.01]**	[0.01]***	[0.01]***	[0.02]***	[0.02]**
Cash reserves & exchange to deposits ratio	-0.17	-0.15	-0.93	-0.94	-0.92	-1.00
	[0.09]*	[0.08]**	[0.14]***	[0.15]***	[0.16]***	[0.15]***
R-squared	0.22	0.23	0.33	0.33	0.39	0.45
Observations	10,589	8,018	4,560	3,534	2,169	1,047

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.00	0.01	0.02	0.03	0.07	0.06
	[0.01]	[0.01]	[0.01]*	[0.01]**	[0.02]***	[0.02]***
Cash reserves & exchange to deposits ratio	-0.16	-0.15	-0.91	-0.92	-0.91	-0.97
	[0.08]**	[0.07]**	[0.14]***	[0.15]***	[0.16]***	[0.16]***
Bank equity (ln)	-0.44	-0.48	-0.54	-0.52	-0.68	-0.54
	[0.05]***	[0.07]***	[0.06]***	[0.08]***	[0.09]***	[0.20]***
R-squared	0.23	0.25	0.34	0.34	0.43	0.44
Observations	10,589	8,018	4,560	3,534	2,169	1,047

Panel B. PDR borders

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.06	-0.04	-0.06	-0.04	-0.05	-0.10
	[0.01]***	[0.02]**	[0.02]**	[0.03]	[0.03]	[0.06]
Cash reserves & exchange to deposits ratio	-0.12	-0.32	-0.93	-0.81	-0.70	-0.70
	[0.04]***	[0.17]*	[0.10]***	[0.12]***	[0.12]***	[0.19]***
R-squared	0.18	0.23	0.35	0.37	0.35	0.39
Observations	5,191	2,535	1,272	923	662	262

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.06	-0.04	-0.06	-0.04	-0.06	-0.11
	[0.01]***	[0.02]**	[0.02]***	[0.03]	[0.03]*	[0.06]*
Cash reserves & exchange to deposits ratio	-0.11	-0.29	-0.84	-0.72	-0.67	-0.68
	[0.04]***	[0.15]*	[0.10]***	[0.11]***	[0.11]***	[0.17]***
Bank equity (ln)	-0.47	-0.54	-0.61	-0.71	-0.68	-0.74
	[0.04]***	[0.05]***	[0.06]***	[0.05]***	[0.07]***	[-0.07]***
R-squared	0.27	0.34	0.43	0.46	0.38	0.46
Observations	5,191	2,535	1,272	923	662	262

Clustered standard errors (at bank-level) in squared brackets.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

Appendix B.3: Conley standard errors

Table 9 reports the Conley standard errors for the treatment effect in the smallest bandwidth around the border (25km radius). It shows that the statistical significance of the treatment coefficient remains unchanged for LAW and PDR after one controls for spatial auto-correlation using a one degree cut-off for longitude and latitude. In the case of the PDR, the statistical significance even increases relative to the p-value computed on the basis of clustered (bank-level) standard errors. In general, a larger degree cut-off increases the level of

statistical significance of the treatment coefficients. Figure 9 illustrates this point for the PDR treatment effect on total lending (25km radius).

Table 9: Treatment effects for LAW and PDR policy (Conley standard errors)

Regressions for 25km radius around borders

	Total lending (ln)	Leverage ratio (ln)
Treatment effect of LAW	0.05 {0.03}*	0.06 {0.03}**
Treatment effect of PDR	-0.10 {0.06}*	-0.11 {0.05}**

Conley standard errors in curly brackets.
Cut-off of one degree for latitude and longitude assumed.
See Table 4 in the main paper for number of observations and R-squared.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

The nature of spatial auto-correlation observed in this paper warrants a remark. Close to the district borders, and depending on the cut-off I use, standard errors corrected for spatial auto-correlation are sometimes (much) smaller than conventional standard errors. This observation suggests the presence of negative spatial auto-correlation. In other words, national banks with high values for outcome variables tended to be close to peers with lower values for the same outcome variables. Competition could be one possible explanation for negative spatial auto-correlation in banking markets if, for example, the expansion of one bank's loans and discounts occurs at the expense of another closely located bank's portfolio. Negative spatial auto-correlation in past financial and banking markets constitutes an interesting phenomenon which would benefit from more research in the future.

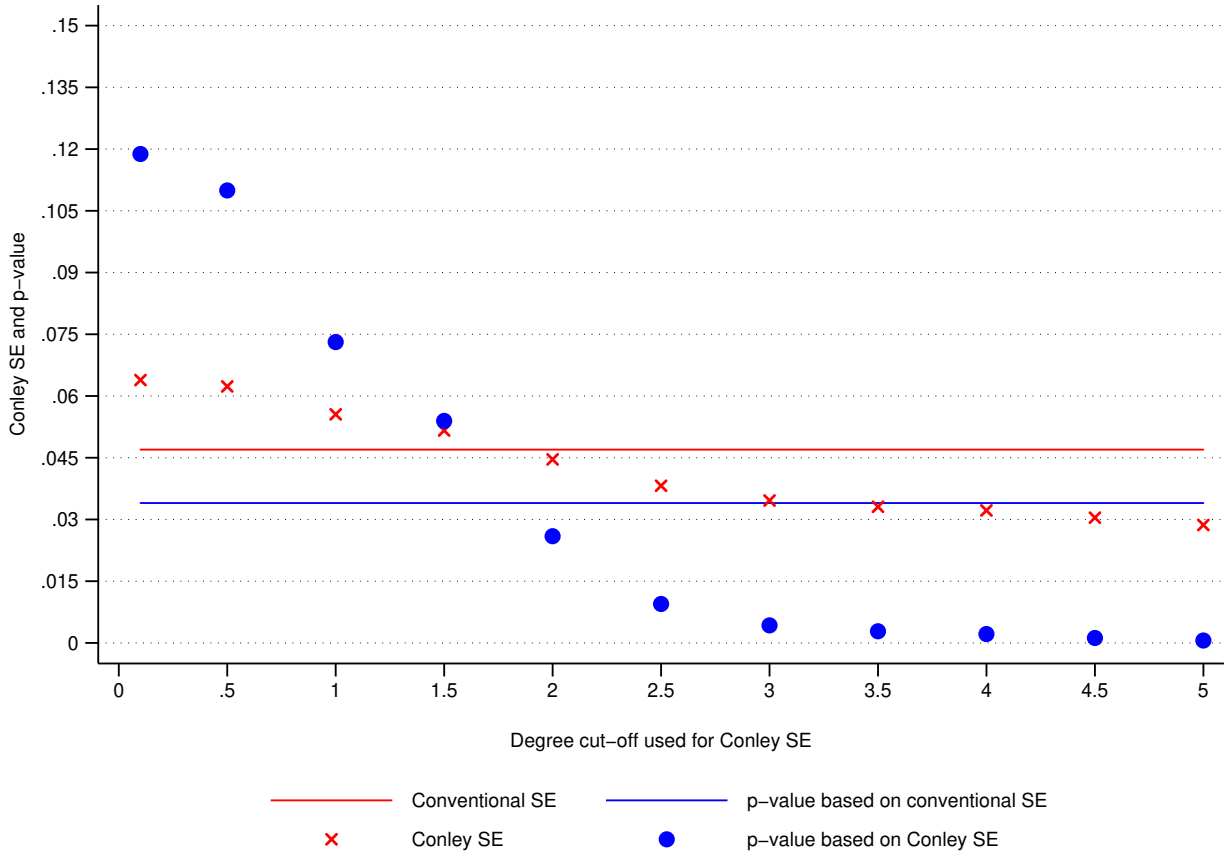
Appendix B.4: Local linear regression

I re-estimate all my baseline models using local linear regressions with a rectangular kernel function.[26] This specification amounts to estimating a standard OLS regression with several pre-specified bandwidths around the district borders. The running variable in my regressions is the linear air-line distance D_i (measured in kilometers) of a given bank's (i) location to the closest district border separating LAW or macroprudential policy districts from districts without policy changes. The cut-off value b in my regression discontinuity design is set to zero and represents the border line between two districts. All control units take negative distance values and all treated units are associated with positive distances. The difference between D_i and b is commonly known as "RDD (regression discontinuity design) polynomial". In the context of local linear regression, the RDD polynomial is a polynomial of order one. Following standard practice, I allow the regression function to differ north and south (or west and east) of the district border by interacting the treatment indicator with the RDD polynomial.[27]

[26] This specification is chosen because local-averaging kernel regressions can introduce a systematic bias in the estimated treatment effect, c.f. Lee and Lemieux (2010).

[27] Omitting this interaction would amount to constraining the slope parameter to be the same on both sides of the border. This constraint would be inconsistent with the core idea of regression discontinuity design because it implies estimating parameters for

Figure 9: Conley standard errors for PDR treatment coefficient on total lending (25km radius)*



Source: Office of the Comptroller of the Currency (1920, 1921a,b, 1922); Rand McNally bankers directory (1920, 1921a,b)

* This graph plots Conley standard errors for the PDR treatment coefficient on total lending (25km radius, treatment coefficient: -0.10) as a function of the degree cut-off for the correction procedure (c.f. red crosses). It also displays the corresponding p-values (blue dots). The red and blue vertical lines show the conventional standard error for the coefficient and the corresponding p-value respectively. The figure illustrates that the statistical significance of the PDR treatment effect is an increasing function in the degree cut-off.

This specification allows for an intuitive interpretation of the treatment effect. If all identification assumptions are met, the only factor which separates treated and control units as D_i approaches the cut-off b (i.e. when the RDD polynomial approaches zero) is the causal effect of LAW or macroprudential policy on the outcome variable Y. Model 1 summarizes these considerations:

$$Y_i = \alpha + \beta T_i + \gamma(D_i - b) + \delta(D_i - b)T_i + \mathbf{\Psi'}\mathbf{X}_i + \kappa_b + u_i \tag{1}$$

where Y_i is the bank-level outcome variable; α is the regression constant; T_i represents an indicator variable taking the value of one if a given bank i is located in a district which implemented LAW or macroprudential policy (and zero otherwise); $(D_i - b)$ is the RDD polynomial; $\mathbf{X}_i$ stands for a vector of bank-level control variables (discussed below); κ_b are border segment fixed effects; and u_i is the bank-specific error term.

The main parameter of interest in Model 1 is β, the effect of LAW or macroprudential policy on bank-level outcomes Y_i. As in local difference-in-differences model, I run two separate series of regressions to estimate β. The first series exploits the policy variation across the borders between the Federal Reserve districts which implemented LAW and the Federal Reserve Banks which did not change policy stance in late spring 1920. In this case, β represents the treatment effect of conventional monetary policy "leaning against the wind". The treated banks in this estimation sample are located either in district 7 (Chicago) or district 2 (New York) and the control units represent banks from the Federal Reserve districts of Cleveland (district 4) and Philadelphia (district 3). The second series of regressions exploits policy differences across borders separating districts subject to the macroprudential policy and districts which did not change policy stance in late spring 1920. In this second case, β measures the treatment effect of macroprudential policy. Treated banks are located in district 6 (Atlanta) or district 8 (St. Louis). The national banks in the Federal Reserve districts of Richmond (district 5) and Cleveland serve as control units. Both series of regressions are estimated for four different bandwidths around the district borders (200, 100, 50 and 25 kilometers). To give a concrete example, a bandwidth of 25 kilometers implies that all national banks located within 25 kilometers on either side of the border will be included in the estimation sample.

Since the local linear regression set-up does not allow for panel data estimation, I draw on the cross-sectional variation in the change of banks' total lending and leverage between January 1920 and September 1921 as my outcomes Y_i. Due to the absence of time variation, I cannot include bank-level and time fixed effects in the local linear regressions set-up. Together with the border segment fixed effects, the more comprehensive control vector $\mathbf{X}_i$, however, should soak up some of the bank-specific heterogeneity. In addition to the covariates used in the main paper, $\mathbf{X}_i$ also contains information on the correspondent relationships of the banks in my sample. I control for the total number of links relative to the size of the loan portfolio, and I also include a dummy variable indicating whether a given bank entertained correspondent relationships with banks located in New

the treated group using data from control units and vice versa (Lee and Lemieux, 2010, p.319).

Table 10: Treatment effects for LAW policy (local linear regression)

Outcome variable: change in total lending (ln, Jan 1920 - Sep 1921)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.05**	0.05*	0.01	-0.01	-0.02	0.02
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)
Cash reserves & exchange to deposits ratio (Δ Jan 1920 - Sep 1921)	-0.14***	-0.25***	-0.24***	-0.20***	-0.23**	-0.14
	(0.04)	(0.06)	(0.07)	(0.08)	(0.09)	(0.13)
Total number of correspondents per 100K loans (Jan 1920)	0.18***	0.16***	0.17***	0.18***	0.17***	0.22***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Correspondent in New York City (dummy, Jan 1920)	-0.02	0.01	0.06**	0.06**	-0.06	-0.09
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)
Total assets (ln, Sep 1921)	0.00	-0.01	-0.02***	-0.03***	-0.01	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
$(D_i - b)$	-0.00	-0.00	-0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$(D_i - b)T_i$	-0.00	-0.00	0.00	0.00*	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Border segment (districts 2-3)	0.08***	0.13***	0.15***	0.15***	0.13***	0.17***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Border segment (districts 2-4)	0.13***	0.18***	0.18***	0.16***	0.14***	0.17***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.06)
Constant	-0.00	0.09	0.18	0.28**	0.25	-0.71***
	(0.08)	(0.09)	(0.11)	(0.13)	(0.15)	(0.24)
R-squared	0.28	0.29	0.28	0.31	0.37	0.53
Observations	2,560	1,935	1,094	846	527	255

Outcome variable: change in leverage ratio (ln, Jan 1920 - Sep 1921)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02	0.03	0.03	0.02	-0.01	0.03
	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)
Cash reserves & exchange to deposits ratio (Δ Jan 1920 - Sep 1921)	-0.14***	-0.29***	-0.26***	-0.23***	-0.24***	-0.15
	(0.04)	(0.06)	(0.07)	(0.07)	(0.09)	(0.13)
Bank equity (ln) (Δ Jan 1920 - Sep 1921)	-0.57***	-0.54***	-0.62***	-0.60***	-0.76***	-0.76***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.05)	(0.08)
Total number of correspondents per 100K loans (Jan 1920)	0.17***	0.15***	0.17***	0.18***	0.17***	0.21***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
Correspondent in New York City (dummy, Jan 1920)	-0.01	0.01	0.04	0.03	-0.07*	-0.10**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.05)
Total assets (ln, Sep 1921)	-0.01***	-0.03***	-0.03***	-0.04***	-0.02	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
$(D_i - b)$	0.00	-0.00	-0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$(D_i - b)T_i$	-0.00*	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Border segment (districts 2-3)	0.09***	0.13***	0.15***	0.15***	0.14***	0.18***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Border segment (districts 2-4)	0.12***	0.16***	0.17***	0.15***	0.14***	0.16***
	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.06)
Constant	0.20***	0.33***	0.31***	0.40***	0.29*	-0.64***
	(0.07)	(0.08)	(0.11)	(0.12)	(0.15)	(0.23)
R-squared	0.43	0.45	0.44	0.46	0.54	0.62
Observations	2,560	1,935	1,094	846	527	255

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

Table 11: Treatment effects for PDR policy (local linear regression)

Outcome variable: change in total lending (ln, Jan 1920 - Sep 1921)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.08**	-0.06	-0.10	-0.12	-0.07	-0.23*
	(0.03)	(0.05)	(0.07)	(0.08)	(0.10)	(0.13)
Cash reserves & exchange to deposits ratio (Δ Jan 1920 - Sep 1921)	-0.05	-0.03	-0.28*	-0.19	-0.13	-0.41
	(0.04)	(0.06)	(0.17)	(0.20)	(0.24)	(0.31)
Total number of correspondents per 100K loans (Jan 1920)	0.23***	0.21***	0.18***	0.19***	0.30***	0.62***
	(0.01)	(0.02)	(0.03)	(0.03)	(0.06)	(0.09)
Correspondent in New York City (dummy, Jan 1920)	-0.13***	-0.14***	-0.10**	-0.15***	-0.22***	-0.39***
	(0.02)	(0.03)	(0.04)	(0.05)	(0.06)	(0.08)
Total assets (ln, Sep 1921)	0.06***	0.04***	0.04**	0.07***	0.11***	0.48***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.07)
$(D_i - b)$	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
$(D_i - b)T_i$	-0.00***	-0.00*	-0.00	-0.00	-0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Border segment (districts 4-6)	0.17**	0.18**	0.25***	0.24**	0.19*	0.12
	(0.08)	(0.08)	(0.08)	(0.10)	(0.10)	(0.14)
Border segment (districts 5-6)	-0.02	0.03	0.07**	0.04	0.01	-0.05
	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)	(0.08)
Constant	-0.61***	-0.43**	-0.43*	-0.76**	-1.27***	-6.44***
	(0.14)	(0.20)	(0.26)	(0.35)	(0.47)	(0.96)
R-squared	0.26	0.20	0.24	0.26	0.25	0.59
Observations	1,251	612	307	225	162	65

Outcome variable: change in leverage ratio (ln, Jan 1920 - Sep 1921)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.09***	-0.05	-0.09	-0.13	-0.10	-0.25*
	(0.03)	(0.05)	(0.07)	(0.08)	(0.10)	(0.13)
Cash reserves & exchange to deposits ratio (Δ Jan 1920 - Sep 1921)	-0.05	-0.04	-0.30*	-0.20	-0.18	-0.37
	(0.04)	(0.05)	(0.16)	(0.19)	(0.24)	(0.31)
Bank equity (ln) (Δ Jan 1920 - Sep 1921)	-0.66***	-0.69***	-0.79***	-0.79***	-0.71***	-1.18***
	(0.03)	(0.04)	(0.05)	(0.06)	(0.09)	(0.14)
Total number of correspondents per 100K loans (Jan 1920)	0.22***	0.20***	0.17***	0.18***	0.29***	0.67***
	(0.01)	(0.02)	(0.03)	(0.03)	(0.06)	(0.10)
Correspondent in New York City (dummy, Jan 1920)	-0.12***	-0.13***	-0.10**	-0.15***	-0.22***	-0.40***
	(0.02)	(0.03)	(0.04)	(0.05)	(0.05)	(0.08)
Total assets (ln, Sep 1921)	0.04***	0.03**	0.03*	0.06**	0.09***	0.55***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.08)
$(D_i - b)$	0.00	-0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
$(D_i - b)T_i$	-0.00*	-0.00	-0.00	0.00	-0.00	0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Border segment (districts 4-6)	0.17**	0.18**	0.23***	0.22**	0.16*	0.12
	(0.08)	(0.08)	(0.08)	(0.09)	(0.10)	(0.14)
Border segment (districts 5-6)	-0.05***	-0.01	0.03	-0.01	-0.06	0.00
	(0.02)	(0.02)	(0.04)	(0.05)	(0.06)	(0.08)
Constant	-0.50***	-0.32	-0.39	-0.63*	-1.10**	-7.27***
	(0.13)	(0.19)	(0.25)	(0.35)	(0.46)	(1.14)
R-squared	0.42	0.42	0.52	0.53	0.47	0.75
Observations	1,251	612	307	225	162	65

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

York City. Finally, I control for bank size as measured in September 1921.

The results of the local linear regression specifications are summarized in Table 10 and Table 11 for LAW and PDR respectively. While the size and sign of coefficients I obtain are similar to the results of the local difference-in-differences (DiD) estimator, the treatment effects are less stable and less precisely estimated with the geographic RDD approach. One explanation is that, since the cross-sectional RDD specification does not allow me to control for bank-level fixed effects, it may not sufficiently capture unobserved heterogeneity at the bank-level. In my setting, some unobserved bank-level characteristics already prevailing before treatment are likely to be correlated with post-treatment outcomes. For example, the individual risk appetite of a given bank's management prior to treatment could influence its decisions regarding the desirable *ex post* level of leverage. Although I include a vector of bank-level covariates ($\mathbf{X}_i$) to account for potential confounding factors, the risk of residual omitted variable bias is thus higher in the cross-sectional RDD set-up than in the local DiD regressions. Moreover, even in the absence of omitted variable bias, the inclusion of adequate control variables can reduce the sampling variability of the estimator in regression discontinuity designs (Lee and Lemieux, 2010). Since some of the potentially relevant controls are latent (e.g. risk appetite) and thus cannot be included in the model, the precision of the estimated treatment coefficients may suffer in the absence of bank-level fixed effects. For these reasons, the local difference-in-differences results reported in the main paper constitute my preferred specification.

Appendix C: Robustness checks

Appendix C.1: Pre-treatment Placebo test

Table 12: Pre-treatment Placebo test for LAW and PDR policy (Sep 1919 - Jan 1920)

Panel A. LAW borders (Placebo treated = Jan 1920)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.01	0.01	0.02*	0.02	0.01	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
R-squared	0.07	0.08	0.09	0.08	0.11	0.06
Observations	5,217	3,952	2,233	1,733	1,065	517

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.01	0.01	0.02	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
R-squared	0.23	0.26	0.22	0.21	0.27	0.17
Observations	5,217	3,952	2,233	1,733	1,065	517

Panel B. PDR borders (Placebo treated = Jan 1920)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.04**	-0.02	-0.02	0.01	-0.00	-0.00
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)
R-squared	0.08	0.08	0.15	0.19	0.14	0.09
Observations	2,553	1,247	621	452	326	129

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.04**	-0.01	0.00	0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)
R-squared	0.21	0.28	0.34	0.29	0.25	0.13
Observations	2,553	1,247	621	452	326	129

Conventional standard errors in parentheses.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

This table provides Placebo test results for pre-treatment effects. The financial stability policies were introduced in late spring 1920. Hence, total lending and leverage of treated banks in LAW and PDR districts should not have evolved differently from control group banks due to treatment before these dates. I test this hypothesis by checking for pre-treatment effects between September 1919 and January 1920. I deliberately stack the cards in favor of finding pre-trends by computing conventional standard errors which result in the smallest p-values.

Appendix C.2: No policy districts Placebo test

Table 13: Testing for policy discontinuities across no policy district borders

Panel A. District 3 (Placebo treated) vs districts 4 and 5

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.01	-0.02*	-0.03**	-0.05***	-0.01	-0.02
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
R-squared	0.21	0.25	0.24	0.26	0.28	0.34
Observations	6,774	4,884	3,179	2,433	1,456	664

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02*	-0.00	-0.01	-0.04***	-0.01	-0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
R-squared	0.24	0.27	0.24	0.27	0.27	0.35
Observations	6,774	4,884	3,179	2,433	1,456	664

Panel B. District 4 (Placebo treated) vs districts 3 and 5

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02**	0.00	0.02	0.02	0.03	0.06
	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.04)
R-squared	0.20	0.29	0.27	0.28	0.29	0.30
Observations	7,415	4,771	2,468	1,829	1,188	613

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.02**	-0.00	0.02	0.02	0.03	0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)
R-squared	0.23	0.29	0.25	0.28	0.26	0.27
Observations	7,415	4,771	2,468	1,829	1,188	613

Panel C. District 5 (Placebo treated) vs districts 3 and 4

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.01	-0.02	-0.01	0.01	-0.03	-0.03
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
R-squared	0.20	0.25	0.26	0.28	0.22	0.23
Observations	7,708	6,015	3,278	2,491	1,571	661

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.05***	-0.03***	-0.03**	-0.00	-0.04*	-0.00
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
R-squared	0.24	0.26	0.25	0.27	0.21	0.20
Observations	7,708	6,015	3,278	2,491	1,571	661

Conventional standard errors in parentheses.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

This table provides results for a robustness test replicating the local difference-in-differences regressions drawing on fictitious policy discontinuities between districts which did not change policy stance in late spring 1920. Districts 3, 4 and 5 did not change policy stance and simply kept the prevailing policy rate at 6%. In the table above, I test for the presence of treatment effects where there should be none by exploiting three combinations of fictitious policy discontinuities between these districts. For each of the three panels, I "pretend" that banks in one of the districts were treated by a financial stability policy, while I assume that financial institutions in the other two districts were not. I deliberately stack the cards in favor of finding a treatment effect by computing conventional standard errors which result in the smallest p-values.

Appendix C.3: Split states results

Table 14: Treatment effects for LAW and PDR: evidence from split states

Panel A. New Jersey (split between LAW and no policy)

Outcome variable: total lending (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.07	0.07	0.07	0.06	0.07	0.10
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.03)***	(0.03)***
	[0.02]***	[0.02]***	[0.02]***	[0.02]**	[0.03]**	[0.04]**
R-squared	0.36	0.36	0.36	0.34	0.34	0.37
Observations	1,246	1,246	1,222	1,018	615	293

Outcome variable: leverage ratio (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.05	0.05	0.05	0.05	0.08	0.10
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.03)***	(0.03)***
	[0.02]***	[0.02]***	[0.02]***	[0.02]***	[0.03]***	[0.04]***
R-squared	0.35	0.35	0.35	0.35	0.38	0.39
Observations	1,246	1,246	1,222	1,018	615	293

Panel B. Kentucky (split between PDR and no policy)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.15	-0.15	-0.11	-0.10	-0.08	-0.10
	(0.03)***	(0.03)***	(0.03)***	(0.04)***	(0.04)**	(0.07)
	[0.04]***	[0.04]***	[0.04]**	[0.05]*	[0.06]	[0.10]
R-squared	0.27	0.28	0.22	0.21	0.19	0.23
Observations	787	648	503	409	342	155

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.15	-0.14	-0.12	-0.09	-0.07	-0.10
	(0.02)***	(0.03)***	(0.03)***	(0.04)**	(0.04)*	(0.07)
	[0.03]***	[0.04]***	[0.04]***	[0.05]*	[0.05]	[0.10]
R-squared	0.21	0.21	0.22	0.16	0.16	0.18
Observations	787	648	503	409	342	155

Standard errors in parentheses. Clustered standard errors (at bank-level) in squared brackets.
† For New Jersey the full sample is equivalent to the 200km radius.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

This table replicates the local difference-in-differences regressions drawing exclusively on bank-level data from two federal states which were split by Federal Reserve district borders with different policies: New Jersey and Kentucky. New Jersey's territory is split between district 2 (LAW) and district 3 (no policy). Kentucky is split between district 8 (PDR) and district 4 (no policy). The split state regressions address the worry that differential (economic) policies at the state-level could bias my estimated treatment effects because such differences may induce a spurious discontinuity in outcome variables across state borders.

Appendix C.4: Post-treatment Placebo test

Table 15: Post-treatment Placebo test for LAW and PDR policy (Jul 1921 - Sep 1921)

Panel A. New Jersey (Placebo treated = Sept 1921)

Outcome variable: total lending (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.02	-0.02	-0.02	-0.01	0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)
R-squared	0.23	0.23	0.24	0.23	0.24	0.28
Observations	429	429	421	351	215	100

Outcome variable: leverage ratio (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.04*	-0.04*	-0.04*	-0.02	0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)
R-squared	0.25	0.25	0.25	0.24	0.32	0.38
Observations	429	429	421	351	215	100

Panel B. Kentucky (Placebo treated = Sept 1921)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.01	0.01	0.03	0.03	0.02	0.01
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.06)
R-squared	0.07	0.06	0.07	0.09	0.17	0.17
Observations	264	218	170	139	116	53

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.01	0.01	0.05	0.04	0.03	0.05
	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.06)
R-squared	0.16	0.20	0.36	0.32	0.40	0.55
Observations	264	218	170	139	116	53

Conventional standard errors in parentheses.
† For New Jersey the full sample is equivalent to the 200km radius.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

This table provides Placebo test results for post-treatment effects. The financial stability policies were discontinued on 16 June 1921 (district 2) and on 23 June 1921 (district 8). Hence, total lending and leverage of treated banks in LAW and PDR districts should not have evolved differently from control group banks due to treatment after these dates. I can test this hypothesis by drawing on split state data from New Jersey and Kentucky because I collected data for the July 1921 call date for national banks located in these states. I deliberately stack the cards in favor of finding post-trends by computing conventional standard errors which result in the smallest p-values.

Appendix C.5: Non-member banks Placebo test

Table 16: Placebo test for LAW and PDR policy: evidence from non-member banks (Jan 1920 - Jan 1921)

Panel A. New Jersey (Placebo treated = non-member banks)

Outcome variable: total lending (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.05	0.05	0.06	0.04	0.02	-0.07
	(0.05)	(0.05)	(0.05)	(0.06)	(0.09)	(0.07)
R-squared	0.33	0.33	0.33	0.33	0.31	0.56
Observations	271	271	266	241	116	54

Outcome variable: leverage ratio (ln)						
	Full sample†	<200km	<100km	<75km	<50km	<25km
Treatment effect	0.03	0.03	0.05	0.03	0.02	-0.06
	(0.05)	(0.05)	(0.05)	(0.06)	(0.10)	(0.07)
R-squared	0.26	0.26	0.26	0.26	0.30	0.54
Observations	271	271	266	241	116	54

Panel B. Kentucky (Placebo treated = non-member banks)

Outcome variable: total lending (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.09**	-0.07	-0.00	0.01	-0.02	0.04
	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.12)
R-squared	0.04	0.06	0.03	0.07	0.06	0.03
Observations	823	634	485	407	314	147

Outcome variable: leverage ratio (ln)						
	Full sample	<200km	<100km	<75km	<50km	<25km
Treatment effect	-0.09**	-0.08	-0.01	0.01	-0.02	0.04
	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.12)
R-squared	0.14	0.12	0.14	0.21	0.13	0.10
Observations	823	634	485	407	314	147

Conventional standard errors in parentheses.
† For New Jersey the full sample is equivalent to the 200km radius.
All regressions with bank FE, time FE and bank-level controls.
*** p<0.01, ** p<0.05, * p<0.1

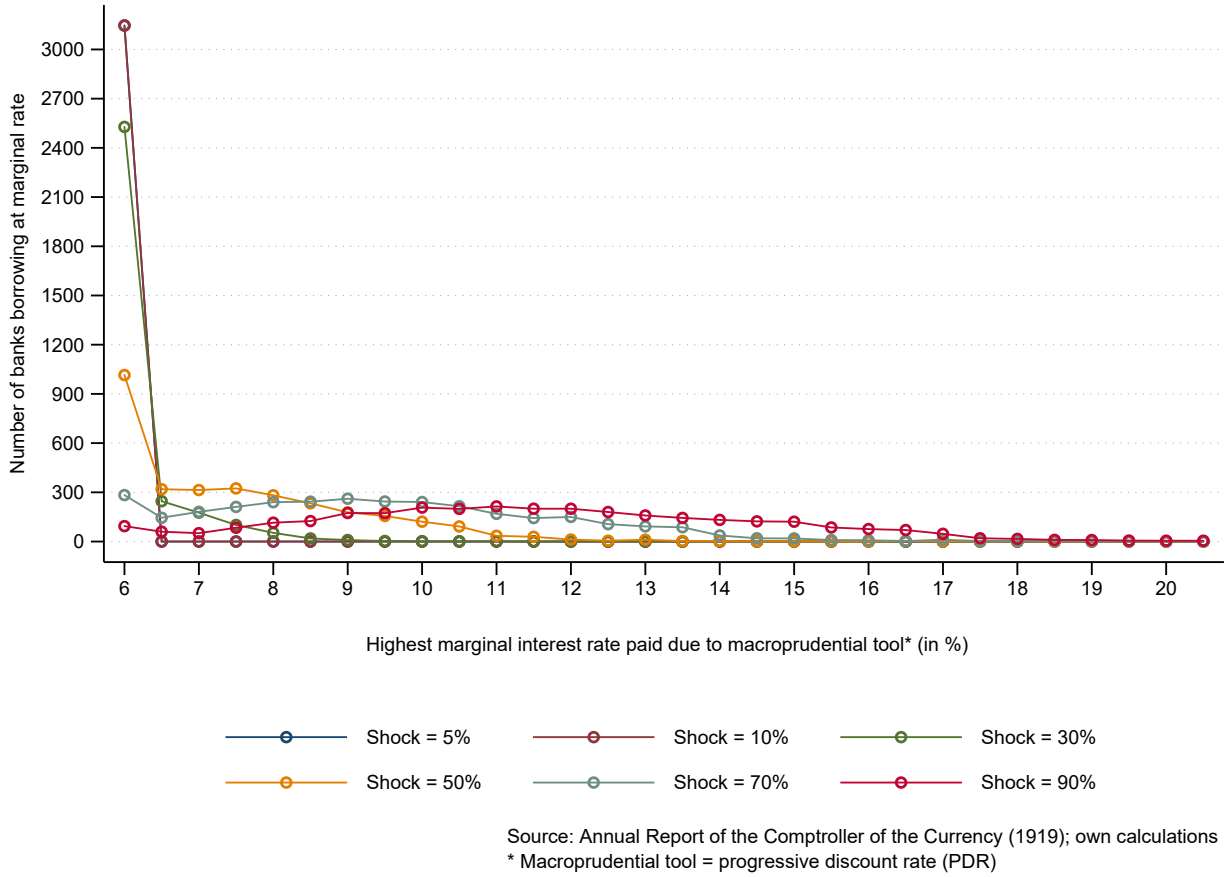
This table provides Placebo test results for non-member banks. State-chartered banks in treated territory, which did not become members of the Federal Reserve System, should have been less strongly affected by the financial stability policies because they did not directly interact with the Federal Reserve Bank in their districts. Non-member banks were not allowed to borrow from the Federal Reserve Banks. I implement the Placebo test using bank-level data from the split states of New Jersey and Kentucky. The split state specification is the cleanest way to test for policy effects on non-member banks because different states had different regulations for state-chartered financial institutions. I deliberately stack the cards in favor of finding a treatment effect by computing conventional standard errors which result in the smallest p-values.

Appendix D: Mechanism

Appendix D.1: Distribution of maximum marginal rates under the PDR policy

The maximum marginal rate is the rate paid by a given bank on the last bit of borrowing. Consider the example of a bank with an entirely unused basic line of $100 which needs to borrow $200 from its Federal Reserve Bank to pay out depositors. This bank will pay 6% on the first $100 of borrowing, 6.5% for the next $25, and so forth until the last $25 of central bank credit, which are borrowed at 8%. In this example, 8% represents the maximum marginal rate of borrowing. Figure 10 suggests that a non-negligible share of banks in the sample would borrow at maximum marginal rates well above 7% even in the scenario where the entire basic line is unused at the moment when the funding shock arrives. Figures 11 and 12 repeat the exercise for basic line usage of 100% and 200% respectively. Holding the the intensity of the funding shock fixed, both figures show that the distribution of maximum marginal rates become less and less skewed as basic line utilization increases. The same is true if one holds basic line utilization fixed, while varying funding shock intensity.

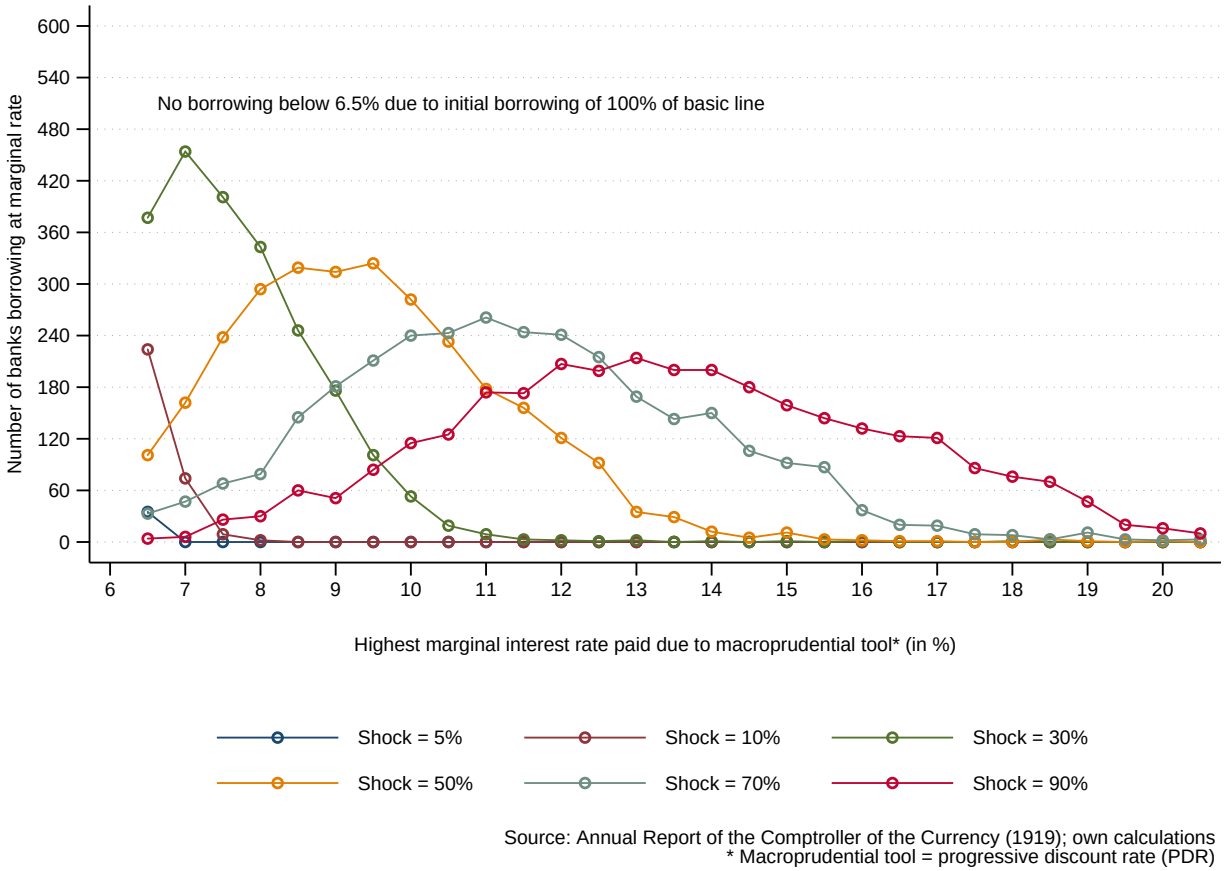
Figure 10: Impact of the PDR: distribution of maximum marginal rates with 0% pre-treatment basic line usage



Source: Office of the Comptroller of the Currency (1920)

Figure 10 shows the distribution of the maximum marginal interest rate at which banks subject to the progressive discount rate would borrow from the Federal Reserve Bank to fund liquidity needs under the assumption of 0% pre-treatment basic line utilization. The stronger the funding shock becomes, the more banks borrow at rates substantially above the 6% flat rate prevailing in non-policy districts.

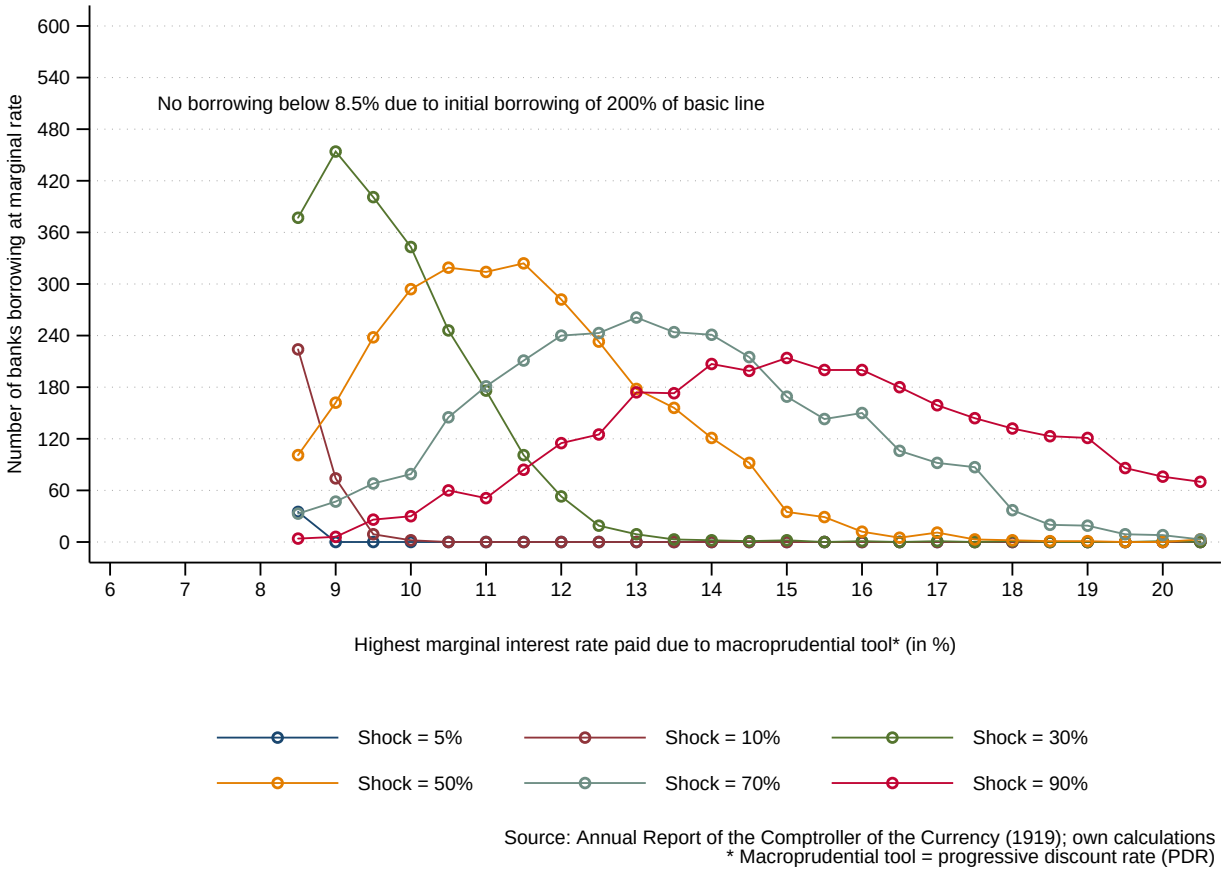
Figure 11: Impact of the PDR: distribution of maximum marginal rates with 100% pre-treatment basic line usage



Source: Office of the Comptroller of the Currency (1920)

Figure 11 shows the distribution of the maximum marginal interest rate at which banks subject to the progressive discount rate would borrow from the Federal Reserve Bank to fund liquidity needs under the assumption of 100% pre-treatment basic line utilization. The stronger the funding shock becomes, the more banks borrow at rates substantially above the 6% flat rate prevailing in non-policy districts. For some banks the highest marginal interest rate is above the 21% threshold if funding shocks are particularly large. Banks whose highest marginal rate is higher than 20% are not shown in Figure 11.

Figure 12: Impact of the PDR: distribution of maximum marginal rates with 200% pre-treatment basic line usage



Source: Office of the Comptroller of the Currency (1920)

Figure 12 shows the distribution of the maximum marginal interest rate at which banks subject to the progressive discount rate would borrow from the Federal Reserve Bank to fund liquidity needs under the assumption of 200% pre-treatment basic line utilization. The stronger the funding shock becomes, the more banks borrow at rates substantially above the 6% flat rate prevailing in non-policy districts. For some banks the highest marginal interest rate is well above the 21% threshold if funding shocks are particularly large. Banks with maximum marginal rates higher than 20% are not shown in Figure 12.

Appendix D.2: Average basic line usage in the Tenth Federal Reserve District

In the aftermath of the short but sharp recession of 1920-21, one of the major political disputes was whether Federal Reserve policy could be made partly responsible for the hardship endured by some agricultural regions at the time. Hence, the Joint Commission of Agricultural Enquiry (1922) collected a wealth of information on the operation of the Federal Reserve System during the years in question. The Commission also had several regional Federal Reserve Bank Governors testify in front of Congress and compiled descriptive data on the functioning of the PDR. The Federal Reserve district of Kansas City, however, remained the only district which presented quantitative data on average basic line usage at these hearings. The reason for this special reporting effort likely was that the developments in the Tenth Federal Reserve district had been scrutinized by the joint congressional Commission in a particularly detailed manner. The Federal Reserve Bank of Kansas City was not only the first Reserve Bank to introduce the PDR scheme on 19 April 1920; it was also the last the one to abolish the system of progressive rates (1 August 1921). Moreover, the Tenth Federal Reserve district registered the highest absolute number of banks borrowing at average interest rates above 10%. Finally, the Bank's Governor J. Z. Miller, Jr., had been one of the most ardent advocates of the PDR in the System. Miller was primarily responsible for the proposal of the Phelan Act of 1920 which officially granted the power to Federal Reserve banks to enact progressive rates (Federal Reserve Board, 1923; Wallace, 1956).

The published data were handed over to the Joint Commission of Agricultural Enquiry (1922) during Governor Miller's congressional testimony. The data are classified into three groups of banks: banks borrowing in excess of their basic line, banks borrowing some share of their basic line smaller than 100% and banks which did not borrow at all from the Federal Reserve Bank. For each category of banks, Table 17 summarizes the number of banks falling into the respective category, the basic lines of these banks, and the banks' total borrowing from the Federal Reserve Bank. The data cover each of the 16 months between April 1920 and July 1921. Based on the raw data, I compute the average basic line usage for the first two categories of banks as well as the total weighted average across all three categories at the end of each month.

Several characteristics of the data require that the information summarized in Table 17 be taken with a grain of salt. First, the Kansas City district is not part of my bank-level estimation sample. Consequently, the data may or may not be representative of developments and policy effects further to the East. Second, my estimation sample includes only national banks whereas the data from the tenth district covers both state member banks and national banks. Third, the most problematic feature is that the aggregate information reported in Table 17 may mask the characteristics of underlying distributions in each category of banks. The Federal Reserve Bank of Kansas City aggregated all basic lines in the tenth district for each of the three categories and contrasted them to the aggregated borrowing of these banks in the respective category. As a corollary, I can only compute the average basic line usage for each group of banks considered as a whole. The underlying distribution of basic line usage and the true weighted average remain hidden in the aggregated data which is driven by the relative contribution of large banks.

Table 17: Average basic line usage in the Federal Reserve District of Kansas City

Colorado

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	26	2190658	2674642.82	122.09%	22	11438612	4214875.49	36.85%	93	12447808	28.26%
May-20	21	1033948	1600429.61	154.79%	45	12225546	7400243.84	60.53%	77	12367584	41.78%
Jun-20	33	2289020	4662143.97	203.67%	46	11962433	7339207.78	61.35%	64	11608071	66.74%
Jul-20	39	2566275	5210933.49	203.05%	40	13447701	9616485.91	71.51%	66	9421911	74.34%
Aug-20	42	2637481	5353396.1	202.97%	44	14361196	7942917.31	55.31%	60	8011975	75.06%
Sep-20	37	1922215	4173594.21	217.12%	50	16136533	11523493.91	71.41%	59	6431438	79.48%
Oct-20	42	2442097	5013744.55	205.30%	46	15881015	8988162.52	56.60%	58	7044596	76.89%
Nov-20	30	2231382	3874287.49	173.63%	43	15365241	6160664.65	40.09%	67	7601302	49.52%
Dec-20	50	3027160	5951738.27	196.61%	34	10060889	6102696.48	60.66%	62	115733	81.46%
Jan-21	53	3140368	6022507.35	191.78%	37	10310308	5819048.29	56.44%	56	10772412	83.92%
Feb-21	55	2946937	5836659.6	198.06%	32	11676470	5372708.14	46.01%	58	8951017	85.28%
Mar-21	45	2575805	4457061.04	173.04%	42	9351896	4314896	46.14%	58	11409632	67.07%
Apr-21	46	2295421	3765966.39	164.06%	46	9681295	4327315.2	44.70%	53	10566360	66.23%
May-21	50	2219400	3553932.39	160.13%	38	6641507	3461015.49	52.11%	57	13162031	68.87%
Jun-21	58	2407799	3977911.03	165.21%	39	12859116	7059651.79	54.90%	49	6124487	80.30%
Jul-21	62	2910222	4687691.88	161.08%	35	9359400	4364055.59	46.63%	49	8936744	79.58%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Kansas (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	42	4086705	7222023.93	176.72%	50	4034280	2068027.14	51.26%	164	14143020	39.01%
May-20	49	4694036	8469654.85	180.43%	54	6406095	2919662.77	45.58%	153	10843688	44.15%
Jun-20	60	5200277	8600683.41	165.39%	43	3554221	1747032.02	49.15%	155	13064913	46.65%
Jul-20	51	4586295	7889854.37	172.03%	50	4140661	2582416.3	62.37%	160	13611768	45.56%
Aug-20	44	3363102	5192143.77	154.39%	49	4699717	3793005.73	80.71%	170	14289923	40.87%
Sep-20	48	4323214	7137790.88	165.10%	56	6445154	3930907.03	60.99%	163	11790804	42.47%
Oct-20	70	7216520	12196210.44	169.00%	61	5053384	2393785.7	47.37%	137	9267068	54.92%
Nov-20	82	7405367	13228607.64	178.64%	66	5317572	2654011.13	49.91%	122	7528180	66.45%
Dec-20	79	6209117	10566351.55	170.17%	78	6711374	3810630.33	56.78%	114	7354454	65.95%
Jan-21	73	5746067	8895933.14	154.82%	69	4730293	2545577.3	53.81%	131	10338967	55.00%
Feb-21	63	4706211	7662806.42	162.82%	75	4959407	2609923.16	52.63%	134	10585565	52.22%
Mar-21	64	4623211	7435131.01	160.82%	72	5996996	2592483.56	43.23%	138	9242125	48.92%
Apr-21	62	4476650	6840884.39	152.81%	75	4308853	2522780.29	58.55%	137	10312741	50.60%
May-21	59	4105415	5910932.13	143.98%	75	4652856	2469420.89	53.07%	141	10103466	45.36%
Jun-21	55	2069153	3196625.44	154.49%	64	5543931	3141568.53	56.67%	156	11453696	44.09%
Jul-21	39	1665602	2488386.45	149.40%	67	5728790	3109728.41	54.28%	169	12321268	34.41%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Missouri (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	18	24684942	59828579.94	242.37%	15	2944519	2116252.62	71.87%	28	2713709	89.19%
May-20	21	21183710	52338072.91	247.07%	15	3816834	2611124.21	68.41%	25	2435427	101.88%
Jun-20	22	22098411	44228703.65	200.14%	14	6876517	4074942.52	59.26%	24	2265463	87.21%
Jul-20	23	22486941	47896403.23	213.00%	16	7806754	5221590.13	66.89%	21	1474511	99.48%
Aug-20	21	21632252	42899903.92	198.31%	16	8943688	3466375.69	38.76%	23	1933637	79.75%
Sep-20	20	20627310	49817764.28	241.51%	12	7594771	5024723.22	66.16%	22	1982336	104.15%
Oct-20	29	21787649	57207029.72	262.57%	12	2462062	1663294.72	67.56%	18	1359803	142.80%
Nov-20	30	27803294	52116388.09	187.45%	13	2520331	1709228.53	67.82%	16	1454402	110.25%
Dec-20	25	21941286	47847713.17	218.07%	17	7462838	2990860.72	40.08%	16	1543533	105.74%
Jan-21	15	10607636	23227319.77	218.97%	25	14874674	10796659.2	72.58%	18	7732000	87.92%
Feb-21	16	10699709	20861079.64	194.97%	24	14247935	10009611.94	70.25%	18	7915548	82.85%
Mar-21	21	19203830	30692598.93	159.83%	18	5703345	3059482.31	53.64%	19	6864776	74.52%
Apr-21	20	18454579	28851007.66	156.34%	18	5706814	3460294.66	60.63%	19	6773039	74.00%
May-21	20	9440655	14637852.58	155.05%	18	18766381	11608845.26	61.86%	19	2489659	73.94%
Jun-21	18	8277734	11930087.19	144.12%	20	14697657	11965099.33	81.41%	18	6657357	75.40%
Jul-21	15	13881453	17986757.72	129.57%	22	8463883	5995084.64	70.83%	19	6646131	62.53%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Nebraska (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	64	19938192	38149239.68	191.34%	62	5129982	2885887.05	56.26%	81	5262530	76.01%
May-20	67	16748403	29125564.31	173.90%	69	5044171	3056947.8	60.60%	71	4140848	76.49%
Jun-20	68	13273418	21828240.93	164.45%	67	8176110	5240751.18	64.10%	72	4118044	74.77%
Jul-20	80	14096013	27184183.94	192.85%	53	6018215	3773073.17	62.69%	74	4175497	90.58%
Aug-20	91	14966386	28369933.58	189.56%	44	5298215	4024832.18	75.97%	71	4316568	99.96%
Sep-20	101	17643636	34588091.04	196.04%	52	3214215	1483506.96	46.15%	52	2968153	108.29%
Oct-20	115	16628100	36457048.98	219.25%	53	3085045	1837127.07	59.55%	40	2139098	136.39%
Nov-20	122	14864385	30000120.03	201.83%	58	5314197	3112827.83	58.58%	30	1618186	133.43%
Dec-20	130	16962341	30195332.24	178.01%	46	2989796	1902333.67	63.63%	34	1848575	124.14%
Jan-21	120	11921726	19934532.09	167.21%	49	3946928	2464866.36	62.45%	41	6491847	110.12%
Feb-21	108	11914884	18710516.03	157.03%	56	3672117	2018626.96	54.97%	46	6889313	95.42%
Mar-21	99	10393940	17779861.31	171.06%	58	6393688	3703447.93	57.92%	51	5671784	97.57%
Apr-21	100	10596752	16890984.48	159.40%	61	5818023	3515997.89	60.43%	48	5025541	93.91%
May-21	92	6248302	9507970.81	152.17%	61	9080736	6008899.87	66.17%	56	5877471	86.30%
Jun-21	89	3961801	6199120.2	156.47%	57	9658836	7081470.22	73.32%	63	7884622	86.63%
Jul-21	78	5613047	7753416.11	138.13%	64	7986294	4397328.38	55.06%	67	8461733	68.41%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

New Mexico (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	1	210040	352730	167.93%	3	242092	120720	49.87%	9	721027	24.43%
May-20	2	216938	418687.16	193.00%	3	152413	74829	49.10%	8	698328	41.02%
Jun-20	4	346550	648743.31	187.20%	3	173287	94121.9	54.32%	6	563946	70.13%
Jul-20	3	298105	629889.27	211.30%	5	413042	238582.71	57.76%	5	386014	70.98%
Aug-20	5	411712	715760.1	173.85%	4	318292	156679.09	49.22%	4	373639	82.01%
Sep-20	6	411453	704524.6	171.23%	3	266544	115605	43.37%	4	355121	89.04%
Oct-20	6	461234	776785.36	168.41%	3	224888	137308.66	61.06%	4	318846	91.82%
Nov-20	6	450214	812430.88	180.45%	4	272794	75416.71	27.65%	3	319279	91.79%
Dec-20	6	556570	1022121.44	183.65%	6	858979	182091.55	21.20%	1	30680	94.54%
Jan-21	8	616548	1066857.52	173.04%	4	277631	234081.05	84.31%	2	42575	122.97%
Feb-21	8	625895	999328.04	159.66%	4	279549	193756.78	69.31%	2	48022	111.04%
Mar-21	8	555610	844677.3	152.03%	4	363415	177512.5	48.85%	2	43767	100.83%
Apr-21	7	421830	553521.76	131.22%	5	439522	283819.09	64.57%	2	43100	88.67%
May-21	6	347516	467251.19	134.45%	7	543441	393256.95	72.36%	2	43927	87.55%
Jun-21	6	320396	442722.06	138.18%	7	661138	454502.39	68.75%	2	40307	87.35%
Jul-21	8	535531	724552.52	135.30%	4	291944	84727.99	29.02%	3	132934	79.90%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Oklahoma (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	22	2117095	2973382.17	140.45%	66	19126766	7735842.35	40.45%	251	17339168	16.99%
May-20	36	4133829	6234776.11	150.82%	79	18166090	9367522.83	51.57%	214	15004410	28.89%
Jun-20	55	4086789	6105553.62	149.40%	84	18780744	10359185.93	55.16%	190	14346333	39.06%
Jul-20	78	5493537	7373169.91	134.22%	88	18725784	11781486.93	62.92%	179	12429095	46.39%
Aug-20	85	8883065	14251072.33	160.43%	88	14830035	9602072.19	64.75%	165	11189448	57.20%
Sep-20	101	8970804	18443309.55	205.59%	88	15146696	9104227.46	60.11%	150	9620328	76.86%
Oct-20	107	11280773	17771553.9	157.54%	98	13492323	9942015.35	73.69%	134	8464968	71.03%
Nov-20	103	12753100	18934583.6	148.47%	110	12105251	8035990.62	66.38%	128	7750183	66.26%
Dec-20	110	13706679	19321997.73	140.97%	109	10813298	6093883.43	56.36%	121	7739190	63.67%
Jan-21	105	10470842	15347196.09	146.57%	118	13924818	8297760.39	59.59%	116	8036268	66.14%
Feb-21	103	6089531	10098527.8	165.83%	113	17544748	10165274.59	57.94%	122	8226050	69.91%
Mar-21	107	5853560	9263278.26	158.25%	108	17411435	11516220.04	66.14%	124	7803117	71.02%
Apr-21	106	6269023	9163998.42	146.18%	122	16484489	11085056.81	67.25%	110	6973922	70.12%
May-21	110	6884655	9527284.58	138.38%	124	15572044	9993896.44	64.18%	104	6669912	68.58%
Jun-21	116	8035283	10606641.24	132.00%	106	13145419	7905589.93	60.14%	116	7202364	64.16%
Jul-21	104	7036710	9839676.98	139.83%	114	12933562	8240141.84	63.71%	119	1269994	64.71%

(Basic lines and total loans shown in current US Dollars.)

Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Wyoming (Table 17 continued from previous page.)

	Banks borrowing above basic line				Banks borrowing below basic line				Banks not borrowing		
Date	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Total loans	Basic line usage	# banks	Basic line	Average basic line usage
Apr-20	5	557682	650448.9	116.63%	11	1084308	503132.97	46.40%	30	3746879	23.77%
May-20	6	617942	1114503.55	180.36%	16	2073403	861151.46	41.53%	24	2567443	37.97%
Jun-20	11	1034263	2067738.09	199.92%	14	2061885	954752.65	46.30%	23	2109974	59.32%
Jul-20	14	951258	2158947.91	226.96%	15	2664456	1580455.94	59.32%	20	1692542	83.00%
Aug-20	18	1991160	3537959.27	177.68%	11	1650078	945269.13	57.29%	20	1605111	78.13%
Sep-20	19	2078566	3488031.11	167.81%	10	1189779	582135.08	48.93%	21	1899605	73.55%
Oct-20	18	1953242	3140836.06	160.80%	9	1038494	556576.17	53.59%	23	2133818	67.54%
Nov-20	13	866900	1510877.64	174.29%	12	1678051	1131505.86	67.43%	25	2533254	61.50%
Dec-20	16	1833422	2423221.17	132.17%	14	1700931	858411.5	50.47%	20	1964731	56.42%
Jan-21	11	1035969	1485153.4	143.36%	23	3132339	1965547.11	62.75%	17	1561958	59.22%
Feb-21	13	1762984	2338387.26	132.64%	22	2407844	1358814.25	56.43%	16	1566661	58.15%
Mar-21	17	1826527	2729030.95	149.41%	17	1737275	1135035.37	65.33%	17	1710416	71.58%
Apr-21	19	2512160	3804032.64	151.42%	17	1248422	692811.46	55.49%	15	1446684	74.91%
May-21	17	2307890	3574753.99	154.89%	19	1190782	744862.78	62.55%	15	1516685	74.93%
Jun-21	21	2286552	3794631.6	165.95%	14	950095	666392.73	70.14%	16	1616989	87.59%
Jul-21	21	2172814	3955107.52	182.03%	18	1296951	806189.95	62.16%	12	1269994	96.89%

(Basic lines and total loans shown in current US Dollars.)

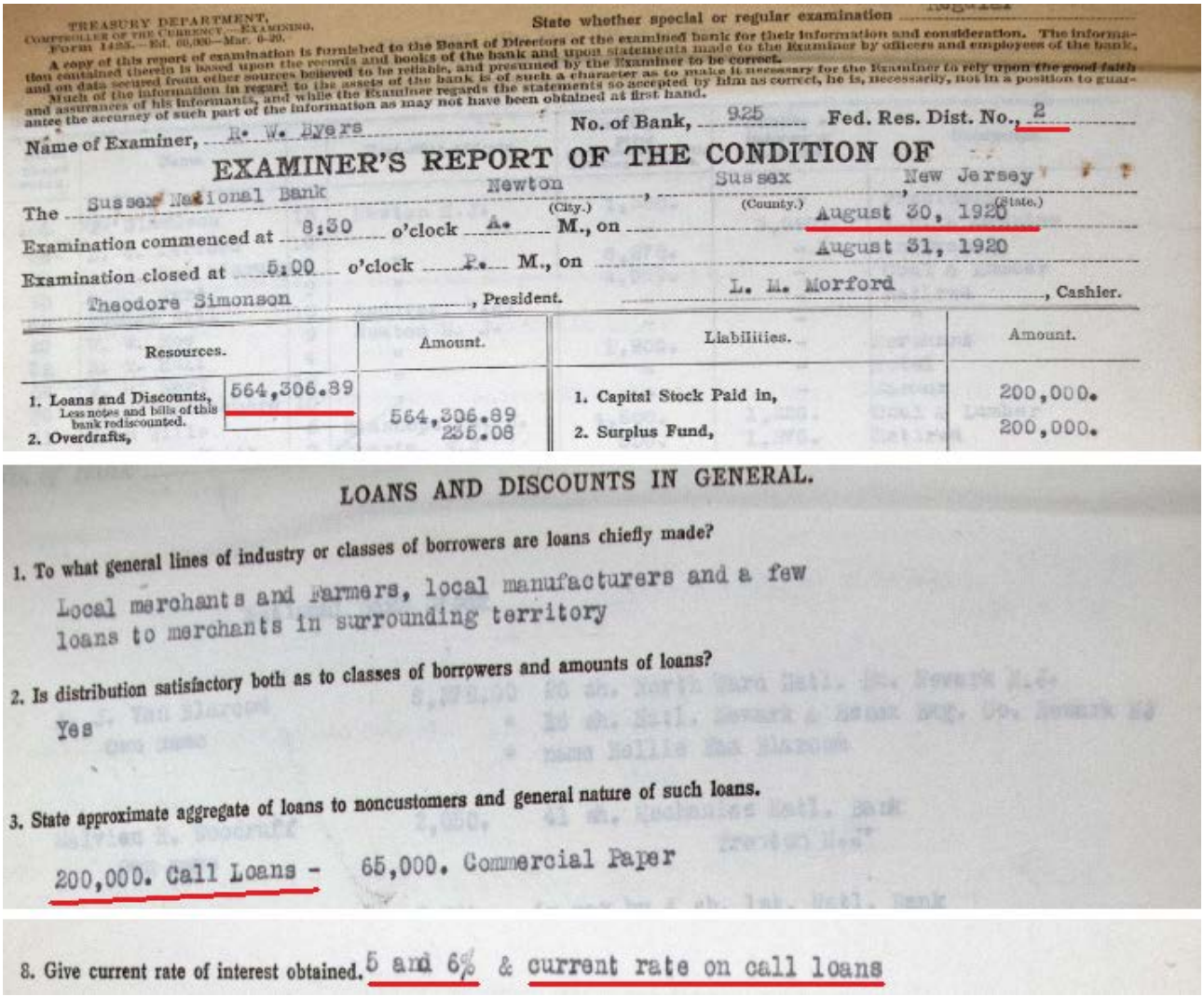
Source: Joint Commission of Agricultural Enquiry (1922); own calculations

Table 17 reports data on member banks' basic lines and total borrowing from the Federal Reserve Bank of Kansas City between April 1920 and July 1921. The data are divided by state and banks are classified according to whether they borrowed from their Federal Reserve Bank above the basic line, below the basic line or not at all. I compute average basic line usage for the first two groups (columns 5 and 9 reading from the left-hand side). I also calculate the overall average basic line utilization in the entire state, taking into account the banks which did not borrow at all (last column).

Appendix D.3: Primary sources for bank-level interest rates and lending decomposition

Figures 13 to 15 show examples for the primary sources I draw on to compile bank-level interest rate data and information on the amount of non-local loans granted by the national banks in my sample. The national examiner reports located at the National Archives in Maryland provide a wealth of data for each national bank. The snippets shown below – which only convey an excerpt of the reports' content – include the title page, the total lending portfolio and a lending survey which contains detailed information on the total amount of non-local loans and interest rates charged by the examined bank. I exploit these data to test whether treated national banks in New Jersey both increased rates and total lending by granting more loans to the NYC call loan market and by purchasing outside commercial paper in reaction to increases in their refinancing costs due to LAW.

Figure 13: Examiner report snippets: Sussex National Bank in Newton, New Jersey



TREASURY DEPARTMENT,
COMPTROLLER OF THE CURRENCY.—EXAMINING.
FORM 1425.—Ed. 60,000—Mar. 6-20.

State whether special or regular examination

A copy of this report of examination is furnished to the Board of Directors of the examined bank for their information and consideration. The information then contained therein is based upon the records and books of the bank and upon statements made to the Examiner by officers and employees of the bank, and on data secured from other sources believed to be reliable, and presumed by the Examiner to be correct.
Much of the information in regard to the assets of the bank is of such a character as to make it necessary for the Examiner to rely upon the good faith and assurances of his informants, and while the Examiner regards the statements so accepted by him as correct, he is, necessarily, not in a position to guarantee the accuracy of such part of the information as may not have been obtained at first hand.

Name of Examiner, R. W. Byers No. of Bank, 925 Fed. Res. Dist. No., 2

EXAMINER'S REPORT OF THE CONDITION OF

The Sussex National Bank, Newton (City.), Sussex (County.), New Jersey (State.)

Examination commenced at 8:30 o'clock A. M., on August 30, 1920

Examination closed at 5:00 o'clock P. M., on August 31, 1920

Theodore Simonson, President. L. M. Morford, Cashier.

Resources.		Amount.	Liabilities.	Amount.
1. Loans and Discounts, Less notes and bills of this bank rediscounted.	564,306.89	564,306.89	1. Capital Stock Paid in,	200,000.
2. Overdrafts,	255.08		2. Surplus Fund,	200,000.

LOANS AND DISCOUNTS IN GENERAL.

1. To what general lines of industry or classes of borrowers are loans chiefly made?

Local merchants and farmers, local manufacturers and a few loans to merchants in surrounding territory

2. Is distribution satisfactory both as to classes of borrowers and amounts of loans?

Yes

3. State approximate aggregate of loans to noncustomers and general nature of such loans.

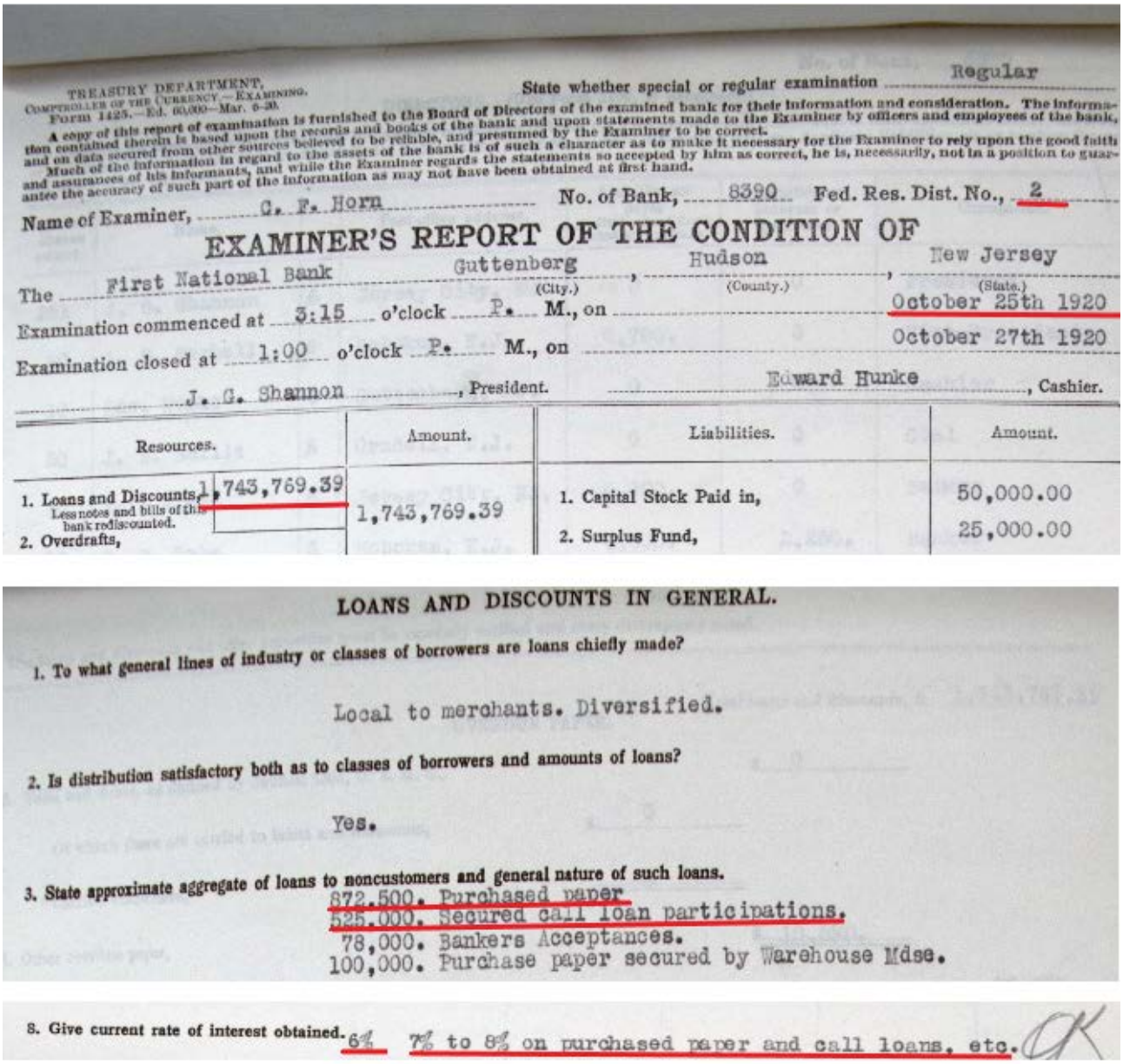
200,000. Call Loans - 65,000. Commercial Paper

8. Give current rate of interest obtained. 5 and 6% & current rate on call loans

Source: National Bank Examiner Reports for 1920

Figure 13 shows several snippets from the national bank examiner reports, including the title page, the total lending portfolio and a lending survey which contains detailed information on non-local loans and interest rates charged by the examined bank.

Figure 14: Examiner report snippets: First National Bank in Guttenberg, New Jersey



TREASURY DEPARTMENT,
COMPTROLLER OF THE CURRENCY—EXAMINING.
Form 1425.—Ed. 60,000—Mar. 6-20.

State whether special or regular examination Regular

A copy of this report of examination is furnished to the Board of Directors of the examined bank for their information and consideration. The information contained therein is based upon the records and books of the bank and upon statements made to the Examiner by officers and employees of the bank, and on data secured from other sources believed to be reliable, and presumed by the Examiner to be correct.
Much of the information in regard to the assets of the bank is of such a character as to make it necessary for the Examiner to rely upon the good faith and assurances of his informants, and while the Examiner regards the statements so accepted by him as correct, he is, necessarily, not in a position to guarantee the accuracy of such part of the information as may not have been obtained at first hand.

Name of Examiner, C. F. Horn No. of Bank, 8390 Fed. Res. Dist. No., 2

EXAMINER'S REPORT OF THE CONDITION OF

The First National Bank (City.) Guttenberg, (County.) Hudson, (State.) New Jersey

Examination commenced at 3:15 o'clock P. M., on October 25th 1920

Examination closed at 1:00 o'clock P. M., on October 27th 1920

J. G. Shannon, President. Edward Hunke, Cashier.

Resources.	Amount.	Liabilities.	Amount.
1. Loans and Discounts, Less notes and bills of this bank rediscounted.	1,743,769.39	1. Capital Stock Paid in,	50,000.00
2. Overdrafts,	1,743,769.39	2. Surplus Fund,	25,000.00

LOANS AND DISCOUNTS IN GENERAL.

1. To what general lines of industry or classes of borrowers are loans chiefly made?

Local to merchants. Diversified.

2. Is distribution satisfactory both as to classes of borrowers and amounts of loans?

Yes.

3. State approximate aggregate of loans to noncustomers and general nature of such loans.

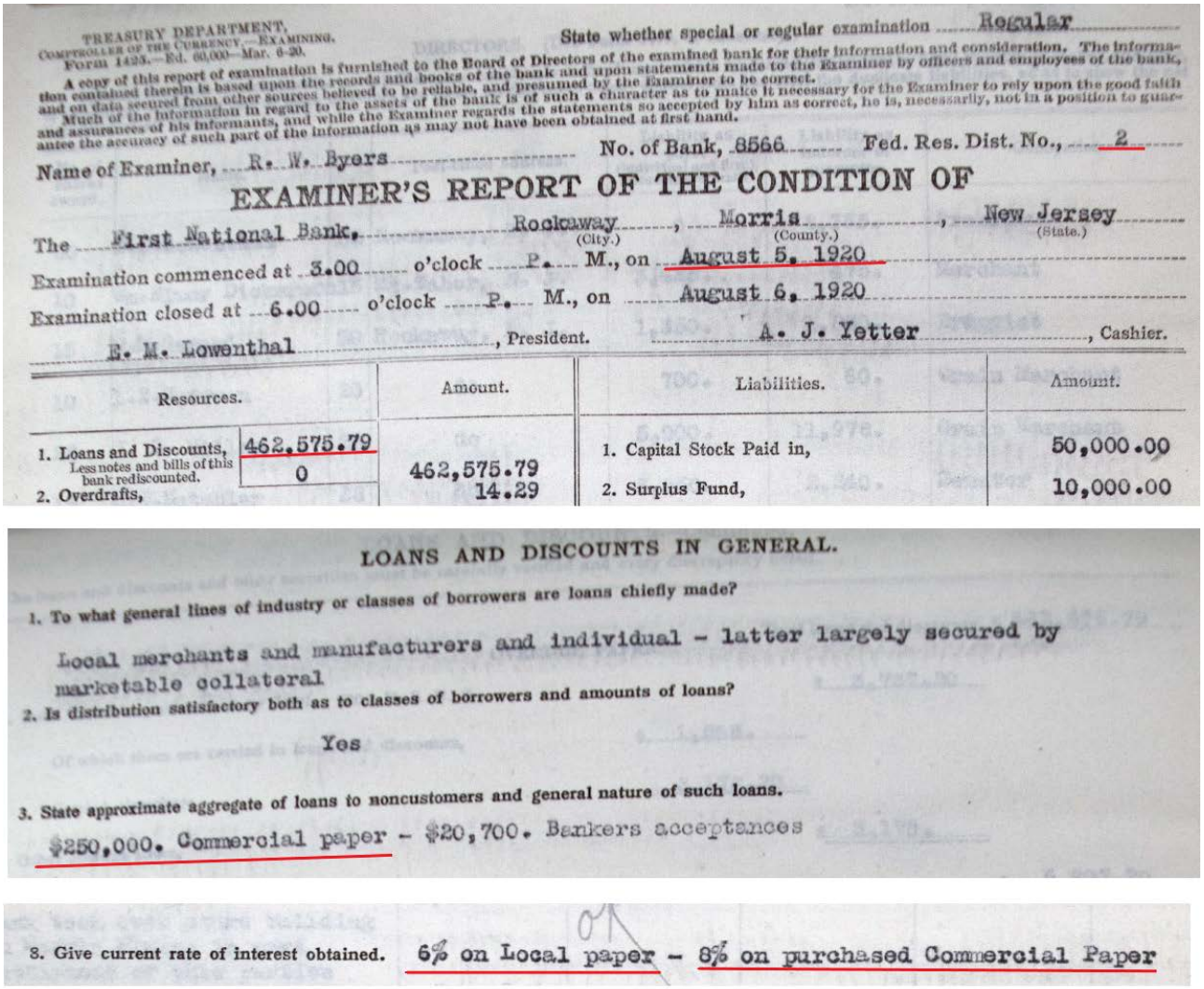
672.500. Purchased paper
525.000. Secured call loan participations.
78,000. Bankers Acceptances.
100,000. Purchase paper secured by Warehouse Mdse.

8. Give current rate of interest obtained. 6% 7% to 8% on purchased paper and call loans, etc. OK

Source: National Bank Examiner Reports for 1920

Figure 14 shows several snippets from the national bank examiner reports, including the title page, the total lending portfolio and a lending survey which contains detailed information on non-local loans and interest rates charged by the examined bank.

Figure 15: Examiner report snippets: First National Bank in Rockaway, New Jersey



TREASURY DEPARTMENT,
COMPTROLLER OF THE CURRENCY.—EXAMINING.
Form 1425.—Ed. 60,000—Mar. 6-20.

State whether special or regular examination Regular

A copy of this report of examination is furnished to the Board of Directors of the examined bank for their information and consideration. The information contained therein is based upon the records and books of the bank and upon statements made to the Examiner by officers and employees of the bank, and on data secured from other sources believed to be reliable, and presumed by the Examiner to be correct.
Much of the information in regard to the assets of the bank is of such a character as to make it necessary for the Examiner to rely upon the good faith and assurances of his informants, and while the Examiner regards the statements so accepted by him as correct, he is, necessarily, not in a position to guarantee the accuracy of such part of the information as may not have been obtained at first hand.

Name of Examiner, R. W. Byers — No. of Bank, 8566 — Fed. Res. Dist. No., 2

EXAMINER'S REPORT OF THE CONDITION OF

The First National Bank, Rockaway (City.), Morris (County.), New Jersey (State.)

Examination commenced at 3.00 o'clock P. M., on August 5, 1920

Examination closed at 6.00 o'clock P. M., on August 6, 1920

E. M. Lowenthal, President. A. J. Yetter, Cashier.

Resources.		Amount.	Liabilities.	Amount.
1. Loans and Discounts, Less notes and bills of this bank rediscounted.	462,575.79 0	462,575.79	1. Capital Stock Paid in,	50,000.00
2. Overdrafts,		14.29	2. Surplus Fund,	10,000.00

LOANS AND DISCOUNTS IN GENERAL.

1. To what general lines of industry or classes of borrowers are loans chiefly made?

Local merchants and manufacturers and individual - latter largely secured by marketable collateral

2. Is distribution satisfactory both as to classes of borrowers and amounts of loans?

Yes

3. State approximate aggregate of loans to noncustomers and general nature of such loans.

$250,000. Commercial paper - $20,700. Bankers acceptances

8. Give current rate of interest obtained. 6% on Local paper - 8% on purchased Commercial Paper

Source: National Bank Examiner Reports for 1920

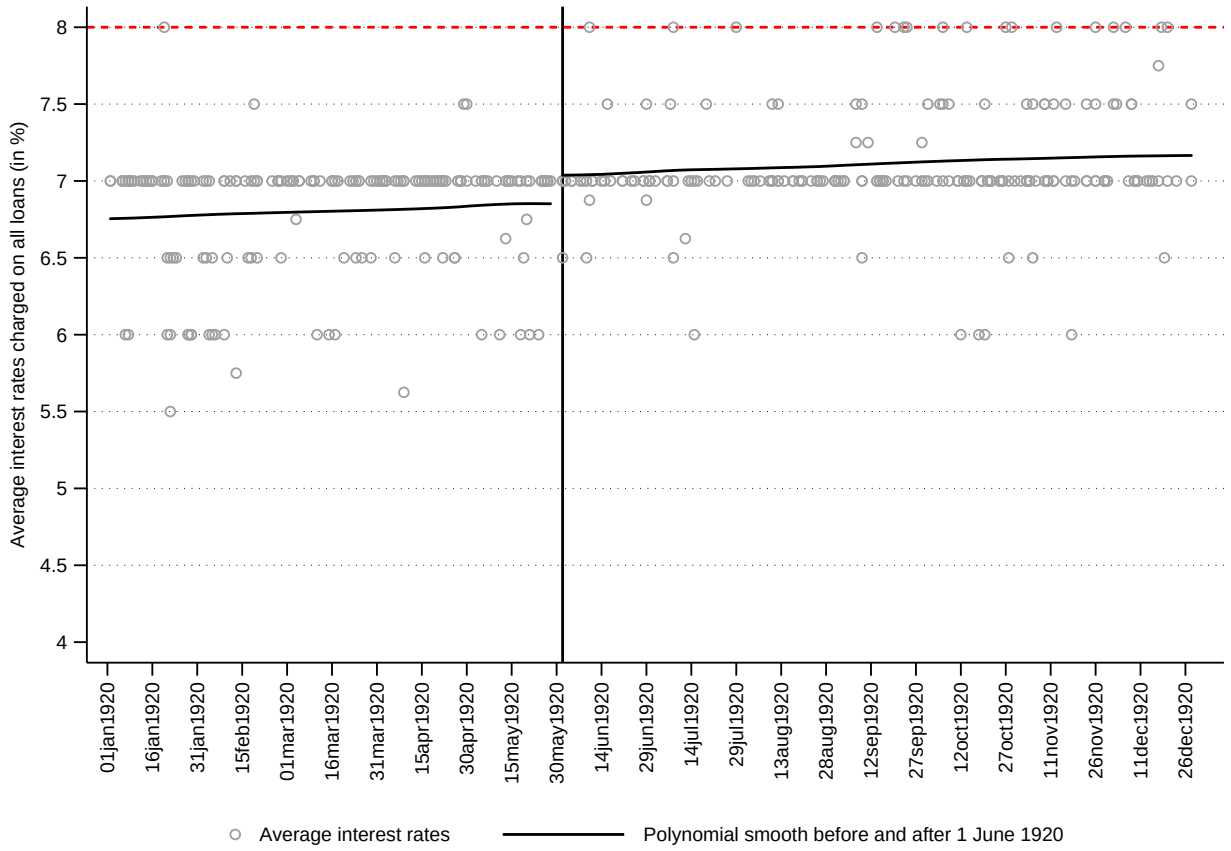
Figure 15 shows several snippets from the national bank examiner reports, including the title page, the total lending portfolio and a lending survey which contains detailed information on non-local loans and interest rates charged by the examined bank.

Appendix D.4: Bank-level interest rates and usury rates in Indiana and Kentucky

Figures 16 to 18 display interest rates charged by national banks in Indiana and Kentucky in 1920. The horizontal dashed red lines represent the respective usury rate ceilings (8% for Indiana national banks and 6% for national banks located in Kentucky). In stark contrast to the evolution of rates prevailing in New Jersey (c.f. main paper), the data for Indiana banks in Figure 16 shows that the usury rate ceiling of 8% was far from binding for average interest rates on all loans. On average, national banks located in Indiana charged interest rates slightly below 7% before 1 June 1920 and only increased them slightly after 1 June 1920. While some individual banks seem to have charged average rates of 8% after 1 June 1920, the mass of the rates distribution remained centered around 7%, i.e. clearly below the usury rate ceiling.

Figures 17 and 18 replicate the local loan and total loan rate schedules for the split-PDR state of Kentucky. The graphs show that while the 6% usury rate on local loans was highly binding in Kentucky, the increase in average rates following 26 May 1920 (the start of the PDR) was relatively subdued compared to New Jersey. The majority of loans remained local in nature. These observations are consistent with the fact that higher refinancing rates resulting from the PDR only affected a subset of very leveraged national banks. Hence, it may explain why Kentucky banks did not engage in a generalized endeavor of regulatory arbitrage similar to the behavior recorded for New Jersey.

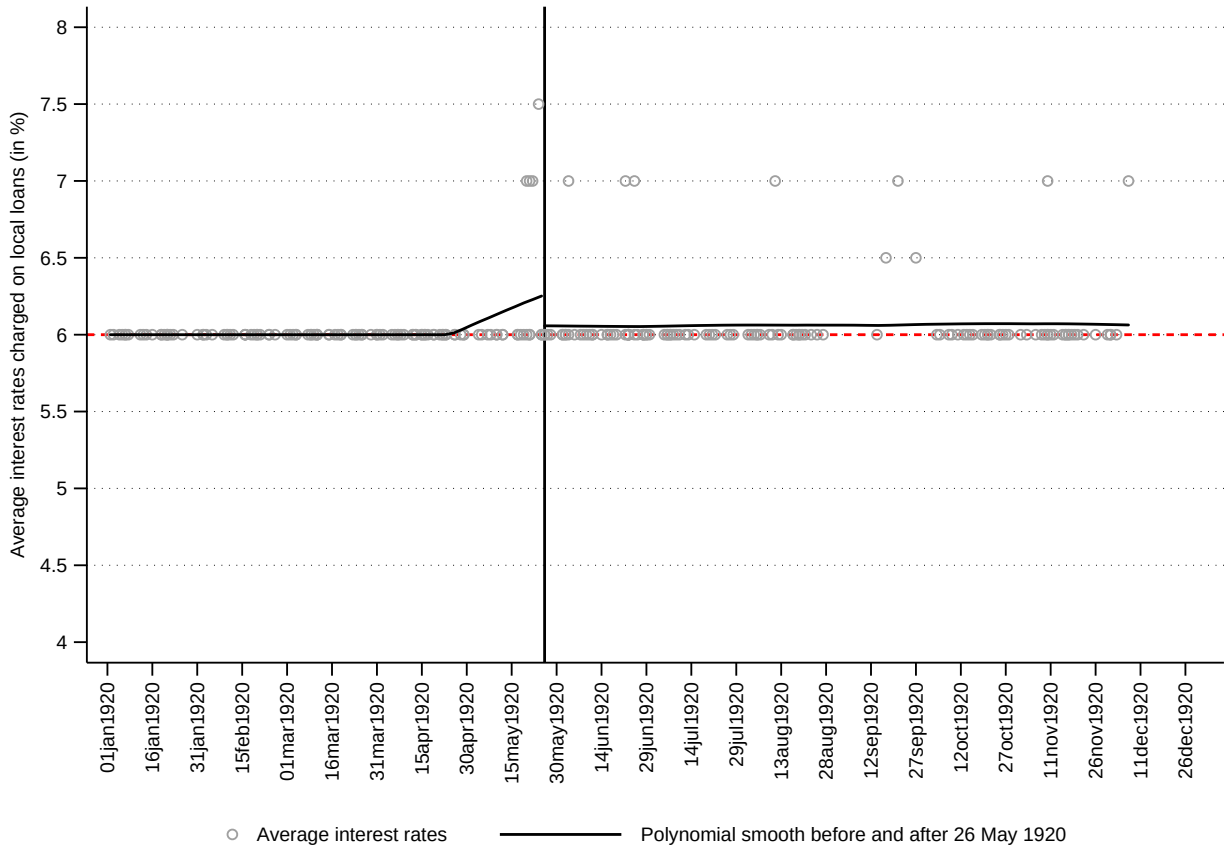
Figure 16: Average interest rate on all loans charged by national banks in Indiana in 1920



Source: National Bank Examiner Reports for 1920

Figure 16 shows bank-level average interest rates on all loans (i.e. local loans, call loans and commercial paper purchases) charged by national banks located in Indiana. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

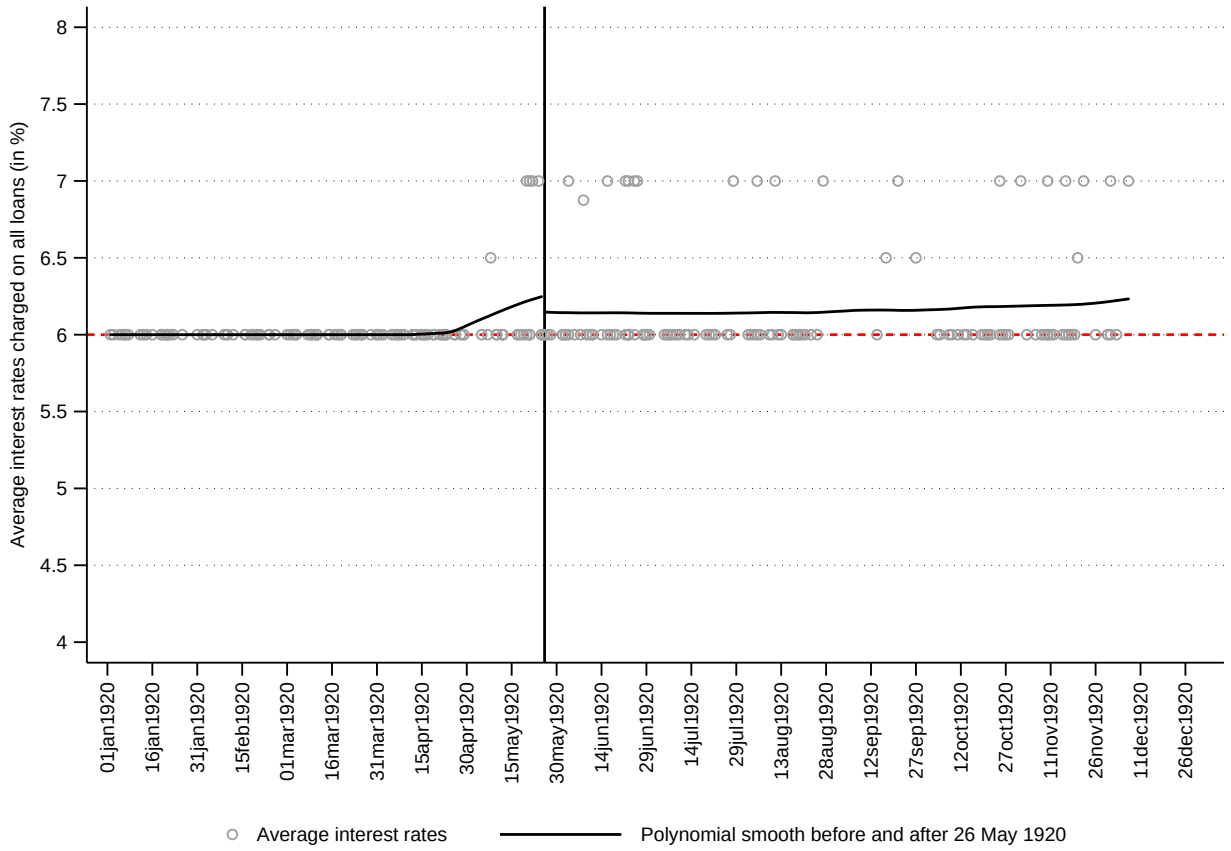
Figure 17: Interest rate on local loans charged by national banks in Kentucky in 1920



Source: National Bank Examiner Reports for 1920

Figure 17 shows bank-level interest rates on local loans (i.e. loans to local customers) charged by national banks located in Kentucky. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

Figure 18: Average interest rate on all loans charged by national banks in Kentucky in 1920



Source: National Bank Examiner Reports for 1920

Figure 18 shows bank-level average interest rates on all loans (i.e. local loans, call loans and commercial paper purchases) charged by national banks located in Kentucky. Each grey circle stands for one bank. The horizontal red dashed line represents the usury rate ceiling. The black line constitutes a polynomial smooth over time of degree zero with an Epanechnikov kernel function.

Appendix D.5: Accounting for the perverse effect of LAW in district 2

Table 18: Mechanisms underlying the perverse effects of LAW: evidence from New Jersey

Panel A. Controlling for average lending rates

Outcome variable: total lending (ln)										
	<200km†	<200km†	<100km	<100km	<75km	<75km	<50km	<50km	<25km	<25km
Treatment effect	0.10***	-0.20	0.10***	-0.20	0.08***	0.00	0.09***	-0.00	0.13***	0.40
	(0.02)	(0.19)	(0.02)	(0.19)	(0.02)	(0.21)	(0.03)	(0.34)	(0.05)	(0.47)
Treatment ×		0.05		0.05		0.01		0.01		-0.04
average rate		(0.03)		(0.03)		(0.03)		(0.05)		(0.07)
R-squared	0.38	0.39	0.39	0.39	0.36	0.36	0.31	0.31	0.32	0.32
Observations	570	570	558	558	414	414	256	256	144	144

Outcome variable: leverage ratio (ln)										
	<200km†	<200km†	<100km	<100km	<75km	<75km	<50km	<50km	<25km	<25km
Treatment effect	0.07***	-0.09	0.07***	-0.09	0.06**	0.13	0.10***	0.28	0.14***	0.35
	(0.02)	(0.18)	(0.02)	(0.18)	(0.02)	(0.19)	(0.03)	(0.33)	(0.04)	(0.42)
Treatment ×		0.02		0.02		-0.01		-0.03		-0.03
average rate		(0.03)		(0.03)		(0.03)		(0.05)		(0.07)
R-squared	0.39	0.39	0.39	0.39	0.39	0.39	0.31	0.32	0.26	0.26
Observations	570	570	558	558	414	414	256	256	144	144

Panel B. Controlling for total loans to non-customers

Outcome variable: total lending (ln)										
	<200km†	<200km†	<100km	<100km	<75km	<75km	<50km	<50km	<25km	<25km
Treatment effect	0.14***	0.38*	0.14***	0.38*	0.11***	0.16	0.13***	-0.31	0.13**	-0.43
	(0.03)	(0.20)	(0.03)	(0.20)	(0.03)	(0.21)	(0.05)	(0.33)	(0.06)	(0.61)
Treatment ×		-0.02		-0.02		-0.00		0.04		0.05
non-customer loans		(0.02)		(0.02)		(0.02)		(0.03)		(0.05)
R-squared	0.42	0.43	0.43	0.43	0.37	0.37	0.33	0.34	0.29	0.30
Observations	428	428	420	420	319	319	194	194	112	112

Outcome variable: leverage ratio (ln)										
	<200km†	<200km†	<100km	<100km	<75km	<75km	<50km	<50km	<25km	<25km
Treatment effect	0.10***	0.45**	0.10***	0.45**	0.09***	0.30	0.13***	-0.07	0.14**	0.09
	(0.03)	(0.18)	(0.03)	(0.18)	(0.03)	(0.19)	(0.04)	(0.32)	(0.05)	(0.56)
Treatment ×		-0.03**		-0.03**		-0.02		0.02		0.00
non-customer loans		(0.01)		(0.01)		(0.02)		(0.03)		(0.05)
R-squared	0.39	0.39	0.39	0.40	0.41	0.41	0.36	0.36	0.23	0.23
Observations	428	428	420	420	319	319	194	194	112	112

Conventional standard errors in parentheses. All regressions with bank FE, time FE and bank-level controls.
† For New Jersey the full sample is equivalent to the 200km radius.
*** p<0.01, ** p<0.05, * p<0.1

This table shows LAW treatment effects for a sub-sample of banks for which OCC examiner report data is available at least twice in 1920 (once before, and once after treatment started). For each radius (200km, 100km, 75km, 50km, and 25km), I first replicate the local difference-in-differences regressions to show that the available sub-sample exhibits very similar positive treatment effects to the full split state sample in Table 14 (columns 1, 3, 5, 7, and 9 in Panel A and B). Subsequently, I re-estimate the regressions after including an interaction term with the average rate banks charged to their customers (columns 2, 4, 6, 8, and 10 in Panel A) and an interaction term with banks' total lending to non-customers (columns 2, 4, 6, 8, and 10 in Panel B). I deliberately stack the cards in favor of finding a treatment effect by computing conventional standard errors which result in the smallest p-values. The results remain qualitatively unchanged if I also control for average rates and total lending to non-customers as additional variables on top of the interaction terms.

References (for appendix)

Bagehot, W. (1873). *Lombard Street: A Description of the Money Market*. London: Henry S. King and Co.

Bignon, V., M. Flandreau, and S. Ugolini (2012). Bagehot for beginners: the making of lender-of-last-resort operations in the mid-nineteenth century. *Economic History Review 65*(2), 580–608.

Cattaneo, M. D., M. Jansson, and X. Ma (2018). Manipulation testing based on density discontinuity. *Stata Journal 18*(1), 234–261.

Cohen-Setton, J. (2016). The making of a monetary union: evidence from the U.S. discount market 1914-1935. *University of California, Berkeley* (Unpublished manuscript), 1–48.

Eichengreen, B. (2016). Doctrinal determinants, domestic and international, of Federal Reserve policy 1914-1933. In *The Federal Reserve's role in the global economy: a historical perspective*. New York: Cambridge University Press.

Federal Reserve Bank of Boston (1920). *Sixth annual report of the Federal Reserve Bank of Boston for the year ended December 31, 1920*. Washington D.C.: Government Printing Office.

Federal Reserve Bank of Minneapolis (1920). *Sixth annual report of the Federal Reserve Agent of the Ninth Federal Reserve District to the Federal Reserve Board*. Washington D.C.: Government Printing Office.

Federal Reserve Board (1920a). *Letter by Governor Harding to the Secretary of the Treasury and the Comptroller of the Currency*. Mimeograph Letters and Statements of the Board of Governors of the Federal Reserve System (Volume 12, January-June 1920), Document number X-1941. Washington D.C.: Board of Governors of the Federal Reserve System.

Federal Reserve Board (1920b). *Minutes of the Board of Governors of the Federal Reserve System (14 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920c). *Minutes of the Board of Governors of the Federal Reserve System (16 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920d). *Minutes of the Board of Governors of the Federal Reserve System (21 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920e). *Minutes of the Board of Governors of the Federal Reserve System (28 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920f). *Minutes of the Board of Governors of the Federal Reserve System (30 January 1920)*. Washington D.C.: United States National Archives and Records Administration.

Federal Reserve Board (1920g). *Notes on the Governors conference held on 17 April 1920*. Mimeograph Letters and Statements of the Board of Governors of the Federal Reserve System (Volume 12, January-June 1920), Document number X-1906. Washington D.C.: Board of Governors of the Federal Reserve System.

Federal Reserve Board (1921). *Seventh annual report of the Federal Reserve Board covering the operations for the year 1920*. Volume I. Washington D.C.: Government Printing Office.

Federal Reserve Board (1923). *Federal Reserve Board conference on 18 May 1920 - Minutes of conference with the Federal Reserve Board of the Federal Advisory Council and the class A directors of the Federal Reserve Banks*. Washington D.C.: Government Printing Office.

Friedman, M. and A. J. Schwartz (1963). *A monetary history of the United States, 1867-1960*. Studies in business cycles. Princeton: Princeton University Press.

Goldenweiser, E. A. (1925). *Federal Reserve System in operation*. New York: McGraw-Hill Book Company.

Gorton, G. and A. Metrick (2013). The Federal Reserve and panic prevention: the roles of financial regulation and lender of last resort. *Journal of Economic Perspectives 27*(4), 45–64.

Humphrey, T. M. (2001). The choice of a monetary policy framework: lessons from the 1920s. *Cato Journal 21*, 285–313.

Jaremski, M. and D. C. Wheelock (2017). Banker preferences, interbank connections, and the enduring structure of the Federal Reserve System. *Explorations in Economic History 66*, 21–43.

Jaremski, M. and D. C. Wheelock (2020). Banking on the boom, tripped by the bust: banks and the World War I agricultural price shock. *Journal of Money, Credit and Banking* (Forthcoming), 1–32.

Joint Commission of Agricultural Enquiry (1922). *Report of the Joint Commission of Agricultural Enquiry*. Part II: Credit. Washington D.C.: Government Printing Office.

Lee, D. S. and T. Lemieux (2010). Regression discontinuity designs in economics. *Journal of Economic Literature 48*(2), 281–355.

McCrary, J. (2008). Manipulation of the running variable in the regression discontinuity design: a density test. *Journal of Econometrics 142*(2), 698–714.

Meltzer, A. H. (2003). *A history of the Federal Reserve*. Chicago; London: University of Chicago Press.

Mitchener, K. J. and G. Richardson (2013). Shadowy banks and financial contagion during the Great Depression: a retrospective on Friedman and Schwartz. *American Economic Review 103*(3), 73–78.

Mitchener, K. J. and G. Richardson (2019). Network contagion and interbank amplification during the Great Depression. *Journal of Political Economy 127*(2), 465–507.

Office of the Comptroller of the Currency (1920). *Annual report of the Comptroller of the Currency on December 1, 1919*. Volume II. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1921a). *Annual report of the Comptroller of the Currency on December 6, 1920*. Volume I. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1921b). *Annual report of the Comptroller of the Currency on December 6, 1920*. Volume II. Washington D.C.: Government Printing Office.

Office of the Comptroller of the Currency (1922). *Annual report of the Comptroller of the Currency on December 5, 1921*. Volume II. Washington D.C.: Government Printing Office.

Rajan, R. and R. Ramcharan (2015). The anatomy of a credit crisis: the boom and bust in farm land prices in the United States in the 1920s. *American Economic Review 105*(4), 1439–1477.

Rand McNally bankers directory (1920). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 48th edition, Jan 1920. New York: Rand McNally & Company, Publishers.

Rand McNally bankers directory (1921a). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 50th edition, Jan 1921. New York: Rand McNally & Company, Publishers.

Rand McNally bankers directory (1921b). *Rand McNally bankers directory and the bankers register with list of attorneys*. Blue book, 51th edition, Jul 1921. New York: Rand McNally & Company, Publishers.

Richardson, G. and W. Troost (2009). Monetary intervention mitigated banking panics during the Great Depression: quasi-experimental evidence from a Federal Reserve district border, 1929–1933. *Journal of Political Economy 117*(6), 1031–1073.

Ryan, F. W. (1924). *Usury and usury laws: a juristic-economic study of the effects of state statutory maximums for loan charges upon lending operations in the United States*. Boston; New York: Houghton Mifflin Company - Riverside Press Cambridge.

Sprague, O. M. W. (1921). The discount policy of the Federal Reserve Banks. *American Economic Review 11*(1), 16–29.

Svensson, L. E. (2017). Cost-benefit analysis of leaning against the wind. *Journal of Monetary Economics 90*, 193–213.

Tallman, E. and E. N. White (2020). Why was there no banking panic in 1920-21? The Federal Reserve Banks and the recession. *ASSA Annual Meetings 2020 EHA Sessions* (Unpublished manuscript), 1–40.

Wallace, R. F. (1956). The use of the progressive discount rate by the Federal Reserve System. *Journal of Political Economy 64*(1), 59–68.

Wicker, E. R. (1966). A reconsideration of Federal Reserve policy during the 1920-1921 depression. *Journal of Economic History 26*(2), 223–238.

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