

The Spatial Transmission of U.S. Banking Panics: Evidence from 1870-1929

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1 Introduction

The United States has a long history of banking panics dating back to the eighteenth century, including at least fifteen waves between 1865 and 1930 ([Jalil, 2015](#)), many of which adversely affected the economy. In this paper, we examine how a banking panic originating in one state is transmitted to others using historical bank balance sheet data from 1870 to 1929.¹

The instability of the U.S. banking system during this period is largely attributable to its institutional structure—specifically, the absence of a central bank until 1913² and unit banking regulations that limited banks’ ability to branch and diversify risks (see [Calomiris and Haber \(2014\)](#)). Consequently, banks formed an interbank market with a pyramidal reserve structure, with central reserve cities—especially New York—at the apex and reserve cities providing liquidity at regional and national levels.³

The interbank lending market presents a trade-off. On one hand, it enables banks to access lower-cost funding and maintain higher levels of credit. On the other hand, it exposes them to runs and panics from outside their home states, facilitating the spatial propagation of distress that the unit banking system would have otherwise contained. We develop a tractable model of interbank relationships within the overlapping inter-state financial network that captures this trade-off and estimate the degree of spatial transmission of panics across states. Our analysis draws on digitized state-level bank balance sheet data from the Annual Report of the Office of the Comptroller of the Currency and the historical banking panic series from [Jalil \(2015\)](#). Section 2 provides a detailed description of our data sources.

We find that regional banking panics transmit significantly across states. Specifically, our empirical analysis shows that such panics are associated with a moderate decline in banking activities across states: deposits and lending fall by 2–4%, and banks subsequently accumulate additional liquid reserves as a buffer. These negative effects are largely transitory, with bank balance sheet indicators returning to pre-crisis trends within two years.

¹We limit our sample to 1870–1929 because the Great Crash of 1929 and the subsequent Great Depression engulfed the entire country simultaneously. Our results are robust even if we limit our sample period to 1870–1913 (i.e., before the Federal Reserve System was created).

²Even upon the creation of the Federal Reserve in 1913, [Anderson et al. \(2018\)](#) find that less than 8% of state-chartered banks joined the Federal Reserve System in its first decade.

³During the National Banking Era, banks in central reserve cities were required to hold reserves equal to 25% of deposits in cash. Banks in reserve cities also had a 25% reserve requirement but could hold half of these reserves as deposits at correspondent banks in central reserve cities. Other national banks were required to hold 15% of deposits, with up to three-fifths of the reserve held as interbank deposits at correspondent banks in reserve or central reserve cities.

Moreover, we observe a lagged but robust response in banks outside the originating state, which we attribute to inter-state financial linkages.

Literature Early documentation of historical panic episodes is provided by [Kemmerer \(1910\)](#) based on newspaper reports. More recent studies by [DeLong and Summers \(1986\)](#), [Gorton \(1988\)](#),⁴ [Wicker \(2006\)](#), [Reinhart and Rogoff \(2009\)](#), and [Jalil \(2015\)](#) offer alternative classifications using different criteria and regional details. In particular, [Jalil \(2015\)](#) provides quantitative estimates of the impact of major nationwide panics on industrial production and prices, indicating large and persistent negative effects. We use the historical banking panic series from [Jalil \(2015\)](#) because of its comprehensive coverage of the geographical and temporal dimensions of panic episodes. [Mitchener and Richardson \(2019\)](#) similarly document the role of interbank lending markets in amplifying lending reductions during the Great Depression,⁵ while our analysis focuses on regional panics preceding the Great Depression.

Finally, [Dordal i Carreras et al. \(2025\)](#) analyze contagion in the modern German interbank network. Drawing on some of their techniques for the aggregation of financial claims within bank network models, this paper develops a framework for the historical U.S. market.⁶

Layout Section 2 details our data sources, including state-level bank balance sheet data and the banking panic series. Section 3 introduces a tractable model of interbank markets and derives the equilibrium relationship between state-level balance sheet indicators. Section 4 presents our estimation strategy and main quantitative results. Section 5 concludes. Figures and tables are presented in Sections I and II, respectively.

Online Appendix A provides additional proofs and derivations for Section 3. Online Appendix B examines the exogeneity of panics using Granger causality tests, and Online Appendix C presents further robustness checks on the estimation of panic propagation.

⁴[Gorton \(1988\)](#) documents that early panics were largely driven by depositors revising their perceptions of fundamental risks in response to new information, rather than by self-fulfilling prophecies. More recently, [Correia et al. \(2024\)](#) show that few bank failures in U.S. history were purely liquidity driven, with failures being highly predictable based on bank fundamentals.

⁵[Mitchener and Richardson \(2019\)](#) show that interbank amplification reduced aggregate commercial bank lending by 15% between the summer peak of 1929 and the winter banking holiday of 1933.

⁶[Anderson et al. \(2022\)](#) study the provision of public liquidity by the Federal Reserve and how it affects the banking system upon the creation of the Federal Reserve system. We abstract from the centralized public liquidity provision and focus on decentralized interbank markets.

2 Data

Banking Panic Series We rely on the historical banking panic series of [Jalil \(2015\)](#), which provides detailed information on the geographical coverage and timing of panics. Table II.2 reproduces this series on a quarterly basis for our sample period (1870–1929) and documents each panic’s state of origin alongside the directly affected states. [Jalil \(2015\)](#) defines a banking panic as a “widespread run by private agents in financial markets … [in order to] convert deposits into currency”⁷ and distinguishes between major and minor panics. Minor panics are geographically localized and less severe, whereas major panics rapidly engulf most of the United States and entail widespread distress.⁸ Given our focus on the spatial propagation of banking panics, we primarily concentrate on minor panics.⁹

State-level Bank Balance Sheets During the National Banking Era (1864–1912), national banks (i.e., those chartered by the federal government) were subject to uniform regulations regardless of location, and operated as unit banks (i.e., single-office banks). They were required to report to their primary regulator, the Office of the Comptroller of the Currency, via *call reports*—filed approximately four or five times per year—that provided bank balance sheet data.¹⁰ We use these call reports for state-level bank balance sheet information.

We collect state-level bank balance sheet aggregates from the Abstract of Reports contained within the Annual Report of the Office of the Comptroller of the Currency. Although [Weber \(2000\)](#) digitized the series for 1880–1910, we extend the dataset to cover 1870–1929 by digitizing data for the remaining years. The dataset comprises self-reported balance sheets from all national banks, aggregated by reserve city and state.¹¹ Table II.1 overviews the categories included, and Figure II.7 shows an example of the Abstract of Reports for banks in Alabama (October 1913–September 1914). The District of Columbia is included and treated as a state, while Alaska and Hawaii are excluded due to their distance from the contiguous United States. We convert the reporting frequency to quarterly, as some years

⁷This narrow definition ensures a homogeneous set of events across the sample period.

⁸Table II.2 identifies three major panics during the sample period: the 1873 panic originating in Europe, the 1893 panic studied by [Calomiris and Carlson \(2017\)](#), and the 1907 panic originating in New York.

⁹Online Appendix B shows that only minor panics pass our exogeneity tests.

¹⁰Banks also submitted *examination reports* based on in-person visits by examiners. For example, in [Calomiris and Carlson \(2017\)](#), inclusion in the sample required a September 1892 call report and at least one examination report prior to May 1893 (the onset of the 1893 major panic).

¹¹For states with a reserve city, we aggregate the state-level variable with that of the corresponding reserve city to obtain the complete state-level balance sheet composition.

feature five reports.

The Abstract of Reports includes various categories (e.g., “Overdrafts”, “Other bonds for deposits”, “Capital stock”) that change over time as broader categories are sub-divided.¹² We group the reported items as follows. On the asset side: (i) loans and discounts; (ii) bonds and securities; (iii) real estate; (iv) cash and short-term assets; and (v) other assets. On the liability side: (i) bank capital; (ii) deposits; and (iii) other liabilities.¹³

Figure I.1 displays the time series of U.S. aggregate log-deposits and New York deposits from 1870 to 1945, overlaid with the timing of minor and major panics from Jalil (2015). The series exhibit clear procyclicality for both New York and the overall United States. Notably, minor panics originating in New York (e.g., the 1884 panic) are associated with substantial declines in deposit levels nationwide.

Note that some works in the literature (Carlson et al., 2022) use balance sheets of individual national banks during the National Banking Era at an *annual* frequency. We instead rely on state-level bank balance sheet aggregates at a *quarterly* frequency for two reasons: a minor panic in the banking panic series of Table II.2 from Jalil (2015) only lasts for a quarter at most; also, the banking panic series of Jalil (2015) defines each minor panic by a state where it originates and other affected states.

3 Model

This section introduces a partial-equilibrium model linking deposit fluctuations to the spatial transmission of panics across U.S. states. Detailed derivations are provided in Online Appendix A.

Consider an economy with N regions—hereafter “states”, reflecting the U.S. setting—each containing a representative bank split into a deposit division that draws local funds and a loan division that lends to local firms. Banks use inter-state interbank lending to cover liquidity gaps across states. Time is discrete in quarters t ; within each quarter, contracts for credit and liquidity are signed continuously over $\tau \in [0, 1]$. Figure 1 outlines the structure.

¹²For example, the category “Loans and discounts” in Table II.1 (and Figure II.7) initially includes “Overdrafts” in the earlier sample, which later becomes a separate category.

¹³For example, in Figure II.7, “Bonds for circulation” and “Bonds for deposits” are grouped under “bonds and securities”, while “Dividends unpaid” and “Reserved for taxes” are grouped under “bank capital”.

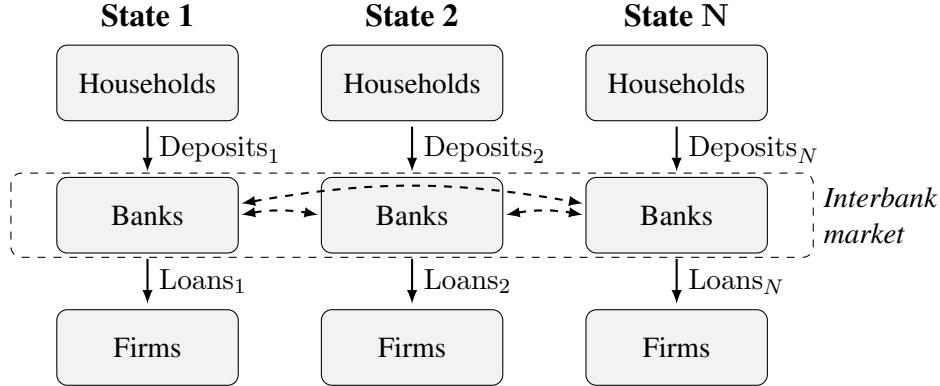


Figure 1: Households in each state allocate savings across banks in the same state in the form of deposits. Banks lend these funds to firms in the same state. Banks in different states form an interbank market where they borrow and lend loanable funds.

Loan Division The loan division of bank i supplies credit to the regional economy in the form of one-period loans, $L_{i,t}^S(\tau) \geq 0$, subject to the following constraint:

$$L_{i,t}^S(\tau) \leq M_{i,t}(\tau) ,$$

where $M_{i,t}(\tau)$ is the total funding available, raised from local depositors and/or via the interbank market. Profits of the loan division are given by

$$\max_{\{L_{i,t}^S(\tau)\}} \int_0^1 \left[R_{i,t}^F(\tau) L_{i,t}^S(\tau) - R_{i,t}^I(\tau) M_{i,t}(\tau) \right] d\tau ,$$

where $R_{i,t}^F(\tau)$ is the interest rate on loans and $R_{i,t}^I(\tau)$ is the effective interest rate on funds obtained from the deposit division or from other banks via the interbank market. Under perfect competition in the credit market, the first-order condition entails $R_{i,t}^F(\tau) = R_{i,t}^I(\tau)$.

Interbank funds $M_{i,t}(\tau)$ are homogeneous and fungible. Accordingly, bank i obtains funds by borrowing from the cheapest available source at each moment τ . Formally,

$$R_{i,t}^I(\tau) = \min_n \left\{ R_{ni,t}^I(\tau) \right\} \quad , \text{ with } n = \arg \min_j \left\{ R_{ji,t}^I(\tau) \right\} , \quad (1)$$

$$M_{i,t}(\tau) = M_{ni,t}(\tau)$$

where $R_{ni,t}^I(\tau)$ is the interbank rate offered by bank n to bank i for a loan amount $M_{ni,t}(\tau)$.

Deposit Division The deposit division in state n collects deposits $D_{n,t}$ from local residents at the beginning of each quarter t and allocates these funds either to its own loan division or to banks in other states via the interbank market. Conversion of deposits into loanable interbank funds is subject to a production constraint given by

$$\sum_{i=1}^N \int_0^1 T_{ni} z_{ni,t}(\tau) M_{ni,t}(\tau) d\tau = (D_{n,t})^\alpha, \quad (2)$$

where exponent $\alpha > 1$ captures economies of scale in processing deposits, and the parameters $T_{ni} \geq 1$ represent the costs of transferring funds across regions—accounting for trade costs, agency problems, or imperfect information. Without loss of generality, we normalize the cost of transferring funds within the same state by setting $T_{nn} = 1$ for all n . The variable $z_{ni,t}(\tau)$ is an exogenous technology shock following a Weibull distribution with unit scale and shape parameter κ , capturing within-quarter variations in the ease of creating loans.¹⁴

The deposit division faces an upward-sloping inverse deposit supply curve, $\rho_n^S(D_{n,t})$, which specifies the interest rate paid on deposits when raising an amount $D_{n,t}$.¹⁵ Its profit maximization problem is therefore

$$\max_{\{M_{ni,t}(\tau)\}, D_{n,t}} \sum_{i=1}^N \int_0^1 R_{ni,t}^I(\tau) M_{ni,t}(\tau) d\tau - \rho_n^S(D_{n,t}) D_{n,t}, \quad (3)$$

subject to the loanable funds production constraint (2).¹⁶

The first-order condition for this problem pins down the interbank loan rate charged by the deposit division of state n on funds lent to state i at moment τ :

$$R_{ni,t}^I(\tau) = T_{ni} z_{ni,t}(\tau) \underbrace{\frac{1}{\alpha} \rho_n^S(D_{n,t}) \left(1 + \frac{1}{\varepsilon_{n,t,D,\rho}^S} \right)}_{\equiv \rho_{n,t}} (D_{n,t})^{-(\alpha-1)}, \quad (4)$$

¹⁴Alternatively, this shock may also represent unmodeled seasonal fluctuations in the demand and supply of loanable funds.

¹⁵We assume that $\rho_n^S(D_{n,t})$ is sufficiently convex to guarantee the existence and uniqueness of the solution to the optimization problem in equation (3) subject to (2). See Online Appendix A for details.

¹⁶The inverse deposit supply curve $\rho_n^S(\cdot)$ can be microfounded by linking deposit compensation to the prevailing risk-free rate on government bonds and to cash holdings with zero return, as in Drechsler et al. (2017).

where $\varepsilon_{n,t,D,\rho}^S \equiv \left[\frac{\rho_n^{S'}(D_{n,t}) D_{n,t}}{\rho_n^S(D_{n,t})} \right]^{-1} > 0$ is defined as the deposit supply elasticity.

Equation (4) implies that an increase in $D_{n,t}$ reduces the interbank rate $R_{ni,t}^I(\tau)$ due to economies of scale ($\alpha > 1$). A less elastic deposit supply (i.e., a lower $\varepsilon_{n,t,D,\rho}^S$) raises the marginal cost of acquiring additional deposits, leading to a higher interbank rate. Finally, a higher trading cost T_{ni} results in a higher equilibrium rate charged by state n to state i . For simplicity, we abstract from state-specific heterogeneity by assuming $\rho_{n,t} \equiv \rho_t$ for all n .¹⁷

Equilibrium When bank i 's loan division supplies credit to the regional economy, it faces an exogenous loan demand given by

$$L_{i,t}^D(\tau) \equiv (R_{i,t}^F(\tau))^{-\beta} \varepsilon_{i,t}, \quad \forall i,$$

where $\varepsilon_{i,t}$ is a regional loan demand shock. The loan market clears in equilibrium, so that $L_{i,t}^D(\tau) = L_{i,t}^S(\tau)$ for all i, t , and τ .

By equation (4) and the properties of Weibull random variables, the effective interbank rate is also distributed Weibull with shape parameter κ and scale parameter $\Phi_{i,t}$, given by¹⁸

$$\Phi_{i,t} = \left(\frac{\rho_t}{\alpha} \right) \left[\sum_{n=1}^N (T_{ni})^{-\kappa} (D_{n,t})^{\kappa(\alpha-1)} \right]^{-1/\kappa}.$$

We find an expression for the aggregate loan demand in a competitive market as

$$L_{i,t}^D \equiv \int_0^1 L_{i,t}^D(\tau) d\tau = \left[\sum_{n=1}^N (T_{ni})^{-\kappa} (D_{n,t})^{\kappa(\alpha-1)} \right]^{\beta/\kappa} \left(\frac{\alpha}{\rho_t} \right)^\beta \Gamma \left(1 - \frac{\beta}{\kappa} \right) \varepsilon_{i,t}. \quad (5)$$

Equation (5) implies that the credit $L_{i,t}^D$ extended in state i is (i) increasing in deposits $D_{n,t}$ in all states n ; (ii) decreasing in the transport cost T_{ni} from state n to state i ; and (iii) decreasing in the uniform deposit rate, ρ_t . Consequently, a decline in $D_{n,t}$ in any state n can lead to a contraction in lending $L_{i,t}$ in other states i . This mechanism underpins our empirical analysis of the transmission of banking panics across states in Section 4.

¹⁷Because $R_{ni,t}^I(\tau)$ is proportional to $T_{ni} z_{ni,t}(\tau)$ at the optimum, the deposit division is indifferent regarding the destination state. This is consistent with the fungibility of interbank funds and the fact that the loan division in state i borrows from the cheapest source at each moment τ .

¹⁸See, e.g., [Dordal i Carreras et al. \(2025\)](#) and [Lee and Dordal i Carreras \(2025\)](#) for further applications and modeling techniques involving extreme value distributions in macroeconomics and finance.

Key Trade-off To illustrate the model's implications, consider two special cases. First, assume that deposits are identical across states, i.e., $D_{n,t} = \bar{D}_t$ for all n , and that transaction costs between different regions are prohibitively high ($T_{ni} \rightarrow \infty$ for $i \neq n$) with $T_{ii} = 1$ for all i . In this case, equation (5) simplifies to

$$L_{i,t}^D = \left(\frac{\alpha}{\rho_t} \right)^\beta \bar{D}_t^{\beta(\alpha-1)} \Gamma \left(1 - \frac{\beta}{\kappa} \right) \varepsilon_{i,t}, \quad \forall i,$$

implying that banks rely solely on domestic deposits to fund their lending. Deposit fluctuations in other states do not affect state i 's loan supply.

In contrast, consider the case with no transaction costs, i.e., $T_{ni} = 1$ for all n, i . Then, equation (5) becomes

$$L_{i,t}^D = N^{\frac{\beta}{\kappa}} \left(\frac{\alpha}{\rho_t} \right)^\beta \bar{D}_t^{\beta(\alpha-1)} \Gamma \left(1 - \frac{\beta}{\kappa} \right) \varepsilon_{i,t}, \quad \forall i,$$

which indicates that banks in any state can supply $N^{\frac{\beta}{\kappa}} > 1$ times more credit given homogeneous deposits. However, the increased credit supply also becomes $N^{\frac{\beta}{\kappa}}$ times more volatile, amplifying the impact of deposit fluctuations and potentially creating instability.

These cases highlight a fundamental risk-return trade-off in the interbank lending system. On one hand, interbank transactions improve the allocation of funds and allow the economy to sustain higher average levels of credit. On the other hand, as equation (5) shows, credit supply becomes linked to deposit fluctuations outside a bank's own state, providing the theoretical foundation for the spatial transmission of banking panics. This mechanism is examined empirically in Section 4 using historical data from the National Banking Era.

4 Empirical Estimation

4.1 Methodology

A log-linear approximation of equation (5) yields¹⁹

$$\log(L_{i,t}) = \mu_i + s_t + \sum_{n=1}^N \tilde{T}_{ni} \log(D_{n,t}) + \epsilon_{i,t}, \quad \forall i, \tag{6}$$

¹⁹The derivation of equation (6) is provided in Online Appendix A.

where μ_i and s_t denote state and seasonal fixed effects, respectively, and \tilde{T}_{ni} captures the sensitivity of loans in state i to deposit fluctuations in state n . For instance, a higher trading cost T_{ni} between states n and i makes it harder for bank n to lend to bank i in the interbank market, thus lowering \tilde{T}_{ni} .

To examine the spatial propagation of panics, we specify \tilde{T}_{ni} as

$$\tilde{T}_{ni} = \lambda_1 + \lambda_2 \log(Distance_{ni}) + \lambda_3 Neighbor_{ni} + \lambda_4 Own_{ni}, \quad (7)$$

where $Distance_{ni}$ is defined as the Euclidean distance between the most populated cities (or geographical centroids) of states n and i , $Neighbor_{ni}$ is a binary indicator equal to one if states n and i share a border, and Own_{ni} is one if $n = i$, with values $\lambda_4 \neq 0$ of the associated coefficient reflecting the “home bias” in interbank lending. In this specification, the sensitivity of loans in state i to deposit fluctuations in state n depends solely on their geographic proximity and neighbor status.

We also assume a linear relationship between deposits and panic events in the data:

$$\log(D_{n,t}) = c_n + \log(D_{n,t-1}) + \phi Panic_{n,t} + v_{n,t}, \quad (8)$$

where $Panic_{n,t}$ is a binary variable equal to one if state n experiences a banking panic in quarter t .²⁰

Combining equations (6), (7), and (8)—which are derived from the partial-equilibrium model in Section 3—we evaluate the spatial and dynamic propagation of panics using Jordà’s Local Projections (Jordà, 2005):

$$y_{i,t+h} = \eta_{i,h}^y + s_{t,h}^y + \sum_{j=1}^4 \theta_{j,h}^y F_{i,t}^j + \sum_{l=1}^L \beta_{l,h}^y \mathbf{X}_{i,t-l} + \epsilon_{i,t+h}, \quad h = 1, \dots, H, \quad (9)$$

where the factors $F_{i,t}^j$ are defined as

$$\begin{aligned} F_{i,t}^1 &= \sum_{n=1}^N \textcolor{blue}{Panic}_{n,t} & F_{i,t}^3 &= \sum_{n=1}^N Neighbor_{ni} \cdot \textcolor{blue}{Panic}_{n,t} \\ F_{i,t}^2 &= \sum_{n=1}^N \log(Distance_{ni}) \cdot \textcolor{blue}{Panic}_{n,t} & F_{i,t}^4 &= \sum_{n=1}^N Own_{ni} \cdot \textcolor{blue}{Panic}_{n,t}, \end{aligned}$$

²⁰For example, for the (minor) panic of 1884, we have $Panic_{NY,1884Q2} = Panic_{PA,1884Q2} = Panic_{NJ,1884Q2} = 1$, with 1884Q2 denoting the second quarter of 1884.

In equation (9), $\eta_{i,h}^y$ and $s_{t,h}^y$ denote state and seasonal fixed effects, respectively, and $\mathbf{X}_{i,t-l}$ is a set of control variables that includes four lags of $\{F_{i,t}^j\}_{j=1}^4$ as well as lags of the dependent variable $y_{i,t}$. For the dependent variable $y_{i,t}$, we consider (i) log deposits; (ii) log loans; (iii) liquidity ratio (the ratio of cash, specie, and short-term assets to total assets in state i); (iv) log average bank capital; and (v) log number of active banks.

The Dimensionality Curse The number of distinct connections between states is N^2 , which rapidly exceeds the available observations. Consequently, the factorization in (9) is essential to reduce the number of parameters to a manageable level. This raises the question of whether the chosen specification adequately captures the spatial transmission of panic episodes. To address this, Online Appendix C examines alternative specifications by (i) employing a more restrictive definition of panics and (ii) incorporating an additional factor for deposit volume in the originating panic states to account for potential scale effects. In both alternatives, the empirical estimates of panic propagation closely align with those obtained from regression (9).

Are Banking Panics Exogenous? In order for regression (9) to be identified, the panic variable $Panic_{n,t}$ must be exogenous (i.e., uncorrelated with the error term $\epsilon_{i,t+h}$). Under this condition, the coefficients $\{\theta_{j,h}^y\}$ capture the causal and spatial dynamics of panic transmission.

Narrative evidence in Jalil (2015) supports this exogeneity assumption. For instance, the 1884 panic in New York was triggered by rumors of misappropriation at the Metropolitan Bank—an event that led to its suspension and subsequent intervention by the New York Clearing House. Similarly, the 1907 panic was sparked by a group of New York financiers misappropriating funds to speculate on rising copper prices, which eventually led to widespread runs on banks. Our own tests in Online Appendix B, based on Granger causality, indicate that the minor panics in Jalil (2015) are independent of the business cycle conditions in the originating state. Therefore, we restrict our analysis in regression (9) to the minor panics listed in Table II.2.

Even if the exogeneity assumption were violated in the states where panics originate, the estimates $\{\theta_{j,h}^y\}$ for spatial transmission remain credible provided that the regional economies of non-origin states are uncorrelated with the causes of the panic in the origin states. This hypothesis is further supported by the unit banking system and restrictions on interstate branching during the sample period, which suggest that the interbank market

is the primary channel for the spatial spread of panics.

4.2 Spatial Transmission: Results

Based on the above discussion on panic exogeneity, we estimate regression (9) focusing exclusively on the minor (regional) panics identified in [Jalil \(2015\)](#). In our specification, if state n experiences a minor panic in quarter t (regardless of its origin), we set $Panic_{n,t} = 1$.

Figures I.2 to I.6 summarize the regression results. They are constructed as follows:

1. We estimate equation (9) for all horizons h and obtain $\{\hat{\theta}_{j,h}^y\}_{j=1}^4$.
2. Assuming a sudden panic in New York (i.e., $Panic_{NY,t} = 1$), we report the impact $\sum_{j=1}^4 \hat{\theta}_{j,h}^y F_{i,t}^j$ for each dependent variable $y_{i,t+h}$.

P-values are computed using Driscoll-Kraay standard errors, which correct for spatial correlation, heteroskedasticity, and autocorrelation.

Figure I.2 shows the evolution of deposits following a panic. The impact ranges from a 4% decline in the simulated origin state to approximately a 3% decline in distant states, indicating rapid spatial transmission across the United States. After one year, deposits in non-origin states display a lagged negative response, although these effects are not statistically significant. By two years, deposits have returned to their pre-panic trend. This pattern is consistent with [Calomiris and Carlson \(2017\)](#) and can be interpreted as sequential deposit runs outside the origin state.²¹

Figure I.3 presents a similar pattern for bank lending. An initial 4% drop in the origin state is accompanied by a 3%-4% decline across other states during the first year. Lending eventually returns to pre-crisis levels in most states, except in the origin and neighboring states, though these differences lose statistical significance over time.

Figure I.4 tracks the liquidity ratio—defined as the ratio of cash, specie, and short-term assets to total assets. The liquidity ratio rises immediately in the origin state and remains 4%-8% above pre-crisis levels nationwide, with significance emerging in many states after 6–7 quarters. This response, together with the stronger negative reaction of bank lending relative to deposits, suggests that banks reallocate their portfolios toward safer assets following panics.

²¹[Gorton \(1988\)](#) documents that, during the National Banking Era, panics were driven by depositors revising their perceptions of underlying risks rather than by self-fulfilling prophecies, leading to sequential deposit runs across states.

Figures I.5 and I.6 show the evolution of average bank capital and the number of active banks, respectively. While there is no immediate impact, bank capital falls by up to 1.5% after two years in several states—particularly in neighboring and distant regions—with significant effects appearing after three quarters. Similarly, the number of active banks declines by 1.5–1.8% after two years, with statistically significant impacts mainly in the origin state and some neighboring states.

Overall, these results align with previous literature on financial crises. In particular, our finding that bank lending declines significantly across states is consistent with the VAR analysis in [Jalil \(2015\)](#), which documents negative effects on both price levels and output following a panic.

In summary, during our sample period, minor panics have a moderate impact on various dimensions of the banking sector, with most effects dissipating after two years. Notably, these panics exhibit robust spatial transmission—affecting even states that are geographically distant from the origin—conditional on the initial structure of interbank loan markets.

5 Conclusions

This paper quantitatively analyzes the impacts and geographic propagation of historical banking panics in the United States. Our tractable model formalizes a key trade-off inherent in the interbank relationships of the National Banking Era. On one hand, interbank loan networks enabled banks to access cheaper funding and expand credit supply; on the other hand, they exposed banks to runs and panics from outside their home states, thus facilitating the transmission of a minor panic in one state to others.

We find that during 1870–1929, a panic in one state was associated with moderate, temporary declines in deposits and lending, increased liquidity holdings, and a small negative impact on bank capital and the number of active banks in many other states. These effects were statistically significant for up to two years after the onset of a panic.

References

Anderson, Haelim, Charles W Calomiris, Matthew Jaremski, and Gary Richardson,
“Liquidity Risk, Bank Networks, and the Value of Joining the Federal Reserve System,”
Technical Report 1 2018.

—, **Selman Erol, and Guillermo Ordoñez**, “Interbank Networks in the Shadows of the Federal Reserve Act,” *Working Paper*, 2022.

Calomiris, Charles W and Mark Carlson, “Interbank networks in the national banking era: their purpose and their role in the panic of 1893,” *Journal of Financial Economics*, 2017, 125 (3), 434–453.

— and **Stephen H Haber**, *Fragile by design: the political origins of banking crises and scarce credit*, Princeton University Press, 2014.

Carlson, Mark, Sergio Correia, and Stephan Luck, “The Effects of Banking Competition on Growth and Financial Stability: Evidence from the National Banking Era,” *Journal of Political Economy*, 2022, 130 (2).

Correia, Sergio A., Stephan Luck, and Emil Verner, “Failing Banks,” 2024. Working Paper.

DeLong, J Bradford and Lawrence H Summers, “The changing cyclical variability of economic activity in the United States,” in “The American Business Cycle: Continuity and Change,” University of Chicago Press, 1986, pp. 679–734.

Dordal i Carreras, Marc, Matthias Hoelzlein, and Jens Orben, “Efficiency, Risk and the Gains from Trade in Interbank Markets,” 2025. Working Paper.

Drechsler, Itamar, Alexi Savov, and Philipp Schnabl, “The Deposits Channel of Monetary Policy,” *The Quarterly Journal of Economics*, 2017, 132 (4), 1819–187.

Gorton, Gary, “Banking panics and business cycles,” *Oxford economic papers*, 1988, 40 (4), 751–781.

Jalil, Andrew J, “A new history of banking panics in the United States, 1825–1929: Construction and implications,” *American Economic Journal: Macroeconomics*, 2015, 7 (3), 295–330.

Jordà, Òscar, “Estimation and inference of impulse responses by local projections,” *American economic review*, 2005, 95 (1), 161–182.

Kemmerer, Edwin Walter, *Seasonal variations in the relative demand for money and capital in the United States: A statistical study*, Vol. 588, US Government Printing Office, 1910.

Lee, Seung Joo and Marc Dordal i Carreras, “Yield-Curve Control Policy under Inelastic Financial Markets,” 2025. Working Paper.

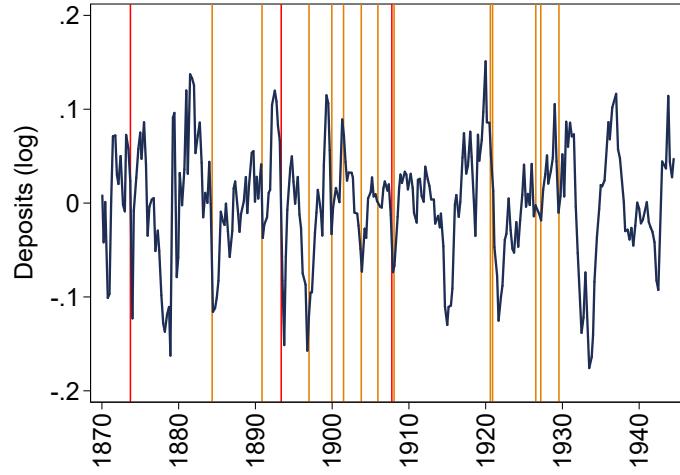
Mitchener, Kris James and Gary Richardson, “Network Contagion and Interbank Amplification during the Great Depression,” *Journal of Political Economy*, 2019, 127 (2).

Reinhart, Carmen M and Kenneth Rogoff, *This time is different: eight centuries of financial folly*, princeton university press, 2009.

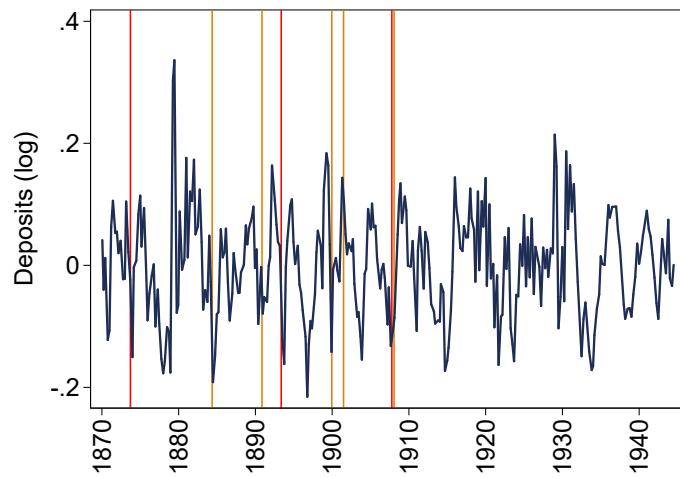
Weber, Warren E, “Disaggregated call reports for US National Banks, 1880-1910,” *Research Department, Federal Reserve Bank of Minneapolis.*, 2000.

Wicker, Elmus, *Banking panics of the gilded age*, Cambridge University Press, 2006.

I Figures



(a) Filtered US aggregate (log)-deposits from 1870 to 1945: the red vertical lines represent major panics according to Jalil (2015), while yellow lines represent the dates of minor panics documented by Jalil (2015) as well.



(b) Filtered (log)-deposits in the state of New York from 1870 to 1945: the red vertical lines represent major panics according to Jalil (2015), while yellow lines represent the dates of minor panics that affected New York, documented by Jalil (2015) as well.

Figure I.1: Time-series deposits of the United States as a whole and the state of New York.

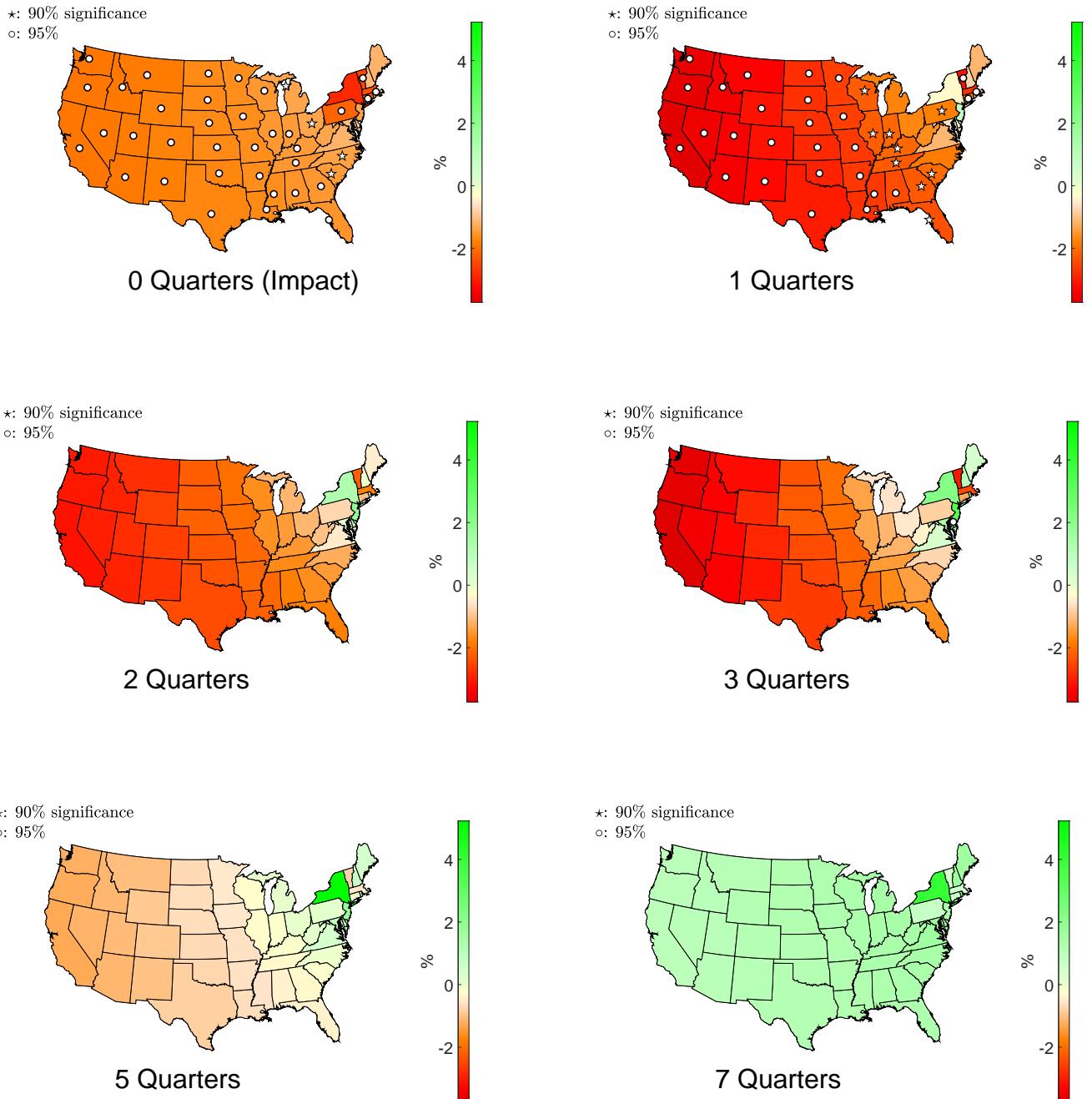


Figure I.2: Impulse-response of bank deposits to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors.

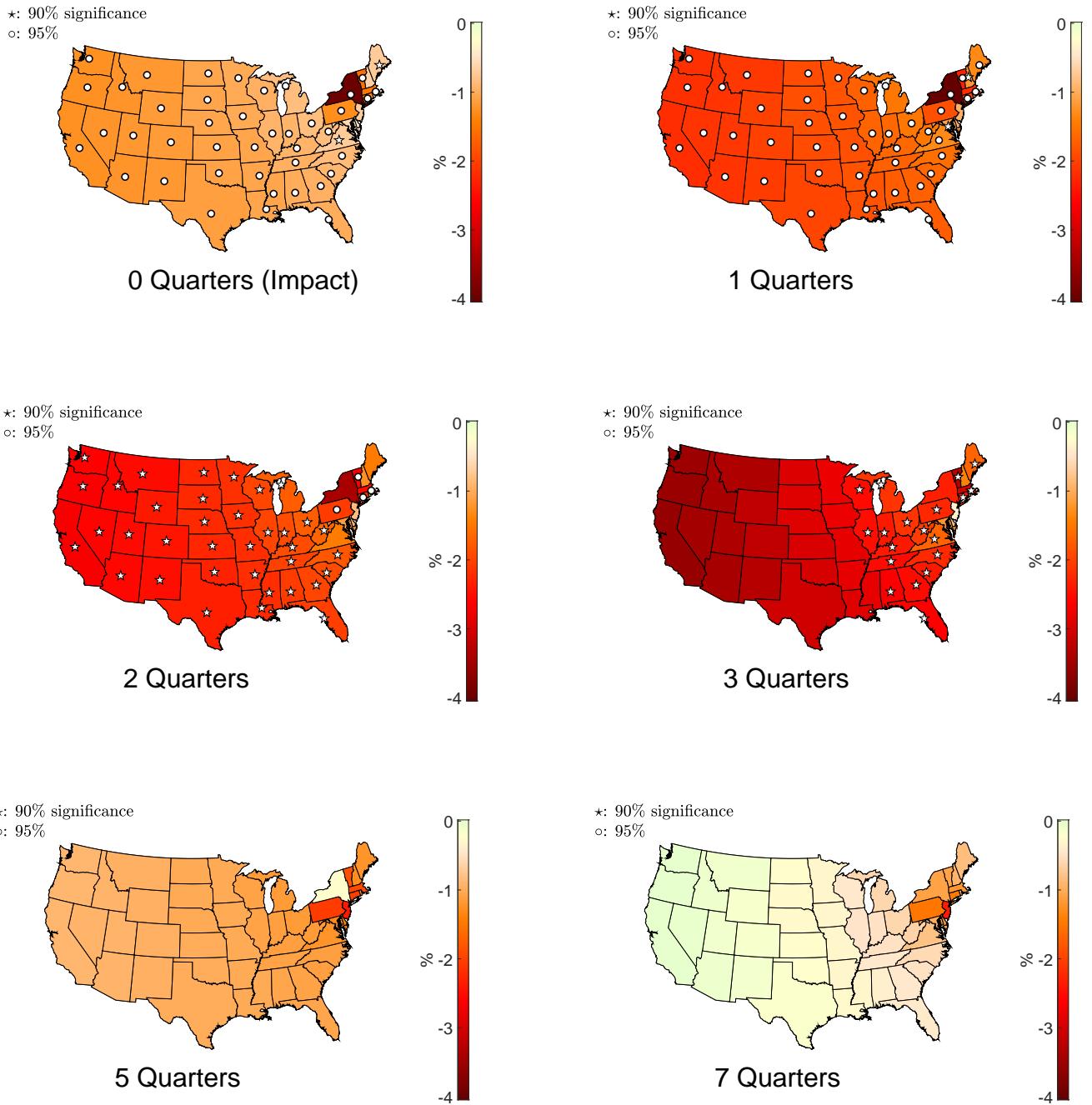
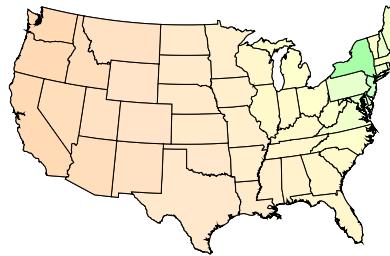


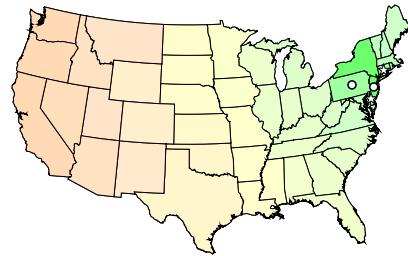
Figure I.3: Impulse-response of bank loans across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$

*: 90% significance
o: 95%



0 Quarters (Impact)

*: 90% significance
o: 95%



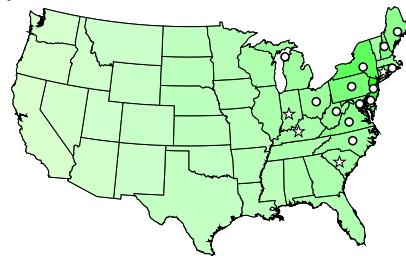
1 Quarters

*: 90% significance
o: 95%



2 Quarters

*: 90% significance
o: 95%



3 Quarters

*: 90% significance
o: 95%



5 Quarters

*: 90% significance
o: 95%



7 Quarters

Figure I.4: Impulse-response of liquidity ratios across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$

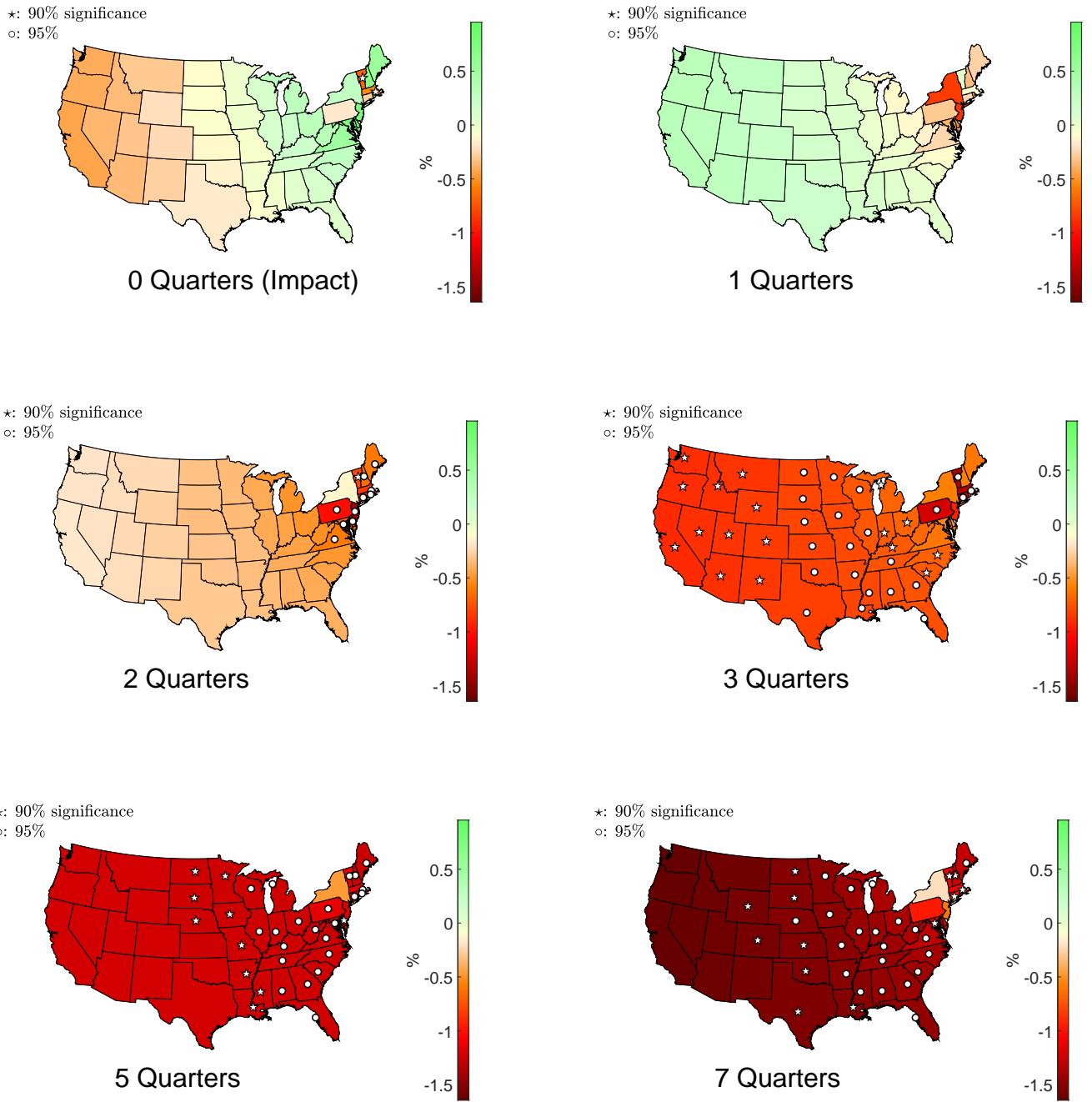


Figure I.5: Impulse-response of bank capital across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$

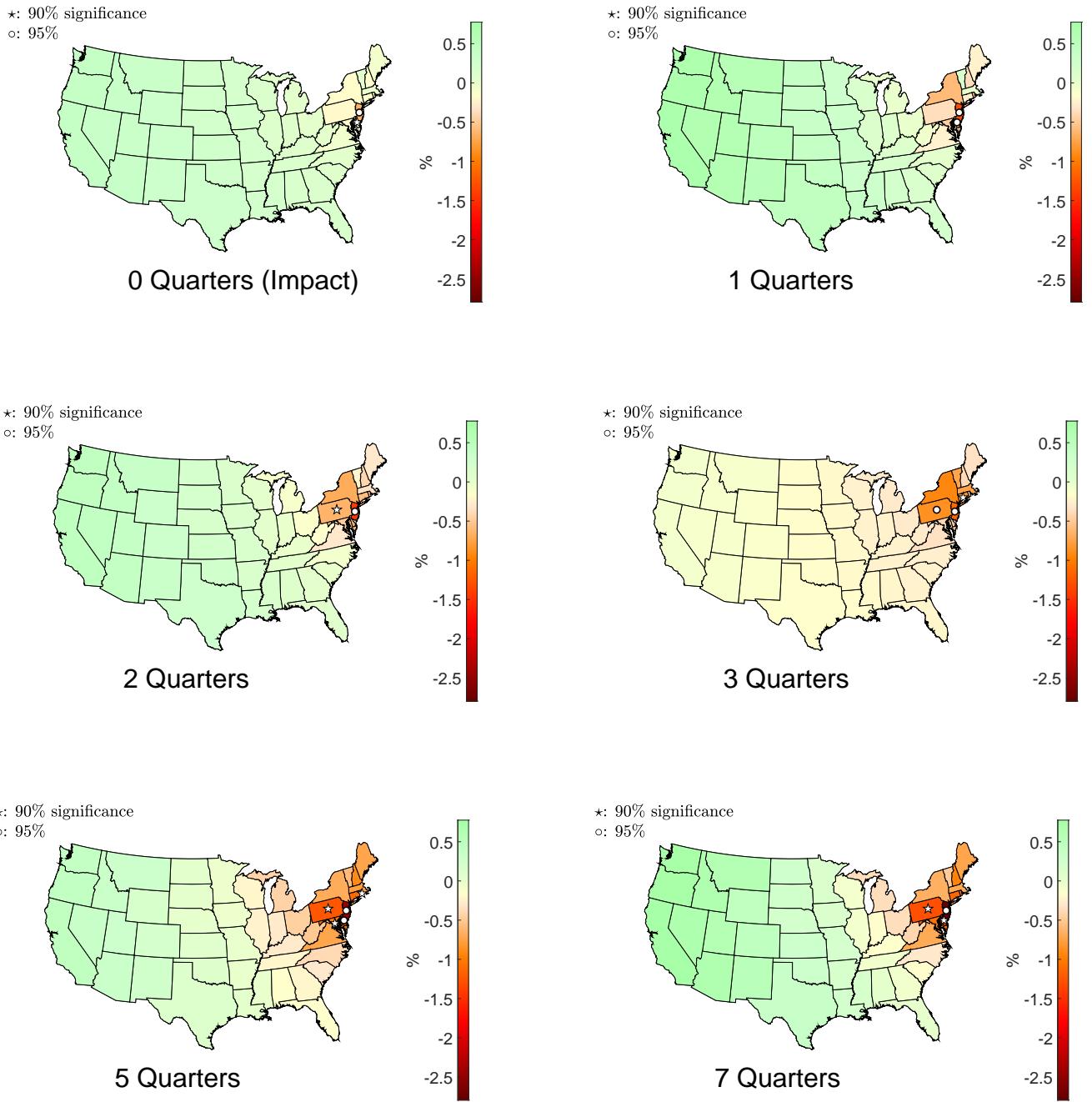


Figure I.6: Impulse-response of the number of banks across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$

II Tables

Resources	Liabilities
Loans and discounts	Capital stock
Overdrafts	Surplus fund
Bonds for circulation	Undivided profits
Bonds for deposits	National bank circulation
Other bonds for deposits	State bank circulation
U.S. Bonds on hand	Due to national banks
Premium on bonds	Due to State banks
Bonds, securities, etc	Due to trust companies, etc
Banking house, furniture, etc	Due to reserve agents
Real state, etc	Dividends unpaid
Current expenses	Individual deposits
Due from national banks	Certified checks
Due from State banks	U.S. deposits
Due from reserve agents	Deposits U.S. disbursing officers
Internal revenue stamps	Bonds borrowed
Cash items	Notes rediscounted
Clearing-house exchanges	Bills payable
Bills of other banks	Clearing-house certificates
Fractional currency	Other liabilities
Trade dollars	Specie
Legal-tender notes	
U.S. certificates of deposit	
Three per cent certificates	
5% fund with Treasury	
Clearing-house certificates	
Due from U.S. Treasury	
Total	Total

Table II.1: Balance sheet original categories of the Abstract of Reports. The Abstract of Reports, contained in the Annual Report of the Comptroller of the Currency, provides regional aggregates of the categories that we list in Table II.1. The categories reported tend to vary slightly across time, typically due to the subdivision of big categories into smaller ones on the latest reports. For example, the category “Loans and discounts” contained “Overdrafts” in the initial years, and overdrafts eventually became a category on its own.

Resources.	OCT. 21, 1913.	JAN. 13, 1914.	MAR. 4, 1914.	JUNE 30, 1914.	SEPT. 12, 1914.
	90 banks.				
ALABAMA.					
Loans and discounts..	\$45,513,715.05	\$42,849,992.35	\$42,905,637.80	\$43,582,574.87	\$41,812,117.43
Overdrafts.....	396,119.39	288,816.63	238,160.73	104,561.68	111,129.33
Bonds for circulation..	8,747,750.00	8,935,750.00	8,934,750.00	9,101,750.00	9,103,749.95
Misc. securities.....					4,861,281.14
Bonds for deposits.....	411,000.00	485,000.00	505,713.00	410,000.00	397,000.00
Other b'ds for deposits..	496,153.75	500,655.64	476,900.75	274,500.00	418,500.00
U. S. bonds on hand..	9,000.00	9,000.00	9,000.00	9,000.00	10,000.00
Premiums on bonds..	91,245.71	78,576.04	77,412.29	70,094.79	63,521.91
Bonds, securities, etc..	3,348,927.54	3,358,970.02	3,308,569.78	3,363,852.16	2,321,201.77
Stocks.....				143,858.49	179,144.71
Banking house, etc....	2,173,798.88	2,169,921.91	2,169,114.21	2,190,582.18	2,196,334.97
Real estate, etc.....	322,342.75	311,914.19	322,095.64	333,964.56	333,918.44
Due from nat'l banks..	4,195,515.45	4,300,854.48	3,666,789.64	2,169,436.13	1,727,789.62
Due from State banks..	1,714,335.10	1,660,222.11	1,303,238.00	976,877.10	845,832.72
Due from res've agts..	6,959,955.73	7,374,465.51	6,348,607.03	,403,111.15	3,215,822.55
Cash items.....	308,028.93	262,611.25	239,394.00	187,521.17	238,991.11
Clear'g-house exch'gs..	324,608.67	250,191.01	311,139.61	270,994.99	179,617.99
Bills of other banks..	889,950.00	1,124,469.00	978,233.00	964,975.00	1,535,034.00
Fractional currency..	29,160.00	41,041.08	45,683.69	45,333.69	42,625.33
Specie.....	2,852,883.16	3,248,435.06	3,002,017.36	3,043,383.10	2,852,801.47
Legal-tender notes..	662,485.00	709,896.00	531,574.00	459,927.00	341,739.00
5% fund with Treas..	424,287.50	429,037.50	413,137.50	434,437.50	561,766.50
Due from U. S. Treas..	33,700.00	39,750.00	14,902.00	21,625.00	5,350.00
Total.....	79,904,962.61	78,429,569.78	75,802,070.12	72,563,370.56	73,355,269.94

(a) An example of balance sheets: asset side of banks in the state of Alabama from October 1913 to September 1914.

Liabilities.	OCT. 21, 1913.	JAN. 13, 1914.	MAR. 4, 1914.	JUNE 30, 1914.	SEPT. 12, 1914.
	90 banks.				
ALABAMA.					
Capital stock.....	\$10,180,290.00	\$10,320,100.00	\$10,375,500.00	\$10,405,000.00	\$10,405,000.00
Surplus fund.....	5,851,293.59	6,042,995.00	6,013,995.00	6,052,170.00	6,119,925.00
Undivided profits.....	1,452,249.96	1,345,635.01	1,623,606.48	1,662,905.41	1,599,714.20
Nat'l-bank circulation..	8,694,175.00	8,885,470.00	8,803,060.00	8,984,400.00	11,008,827.50
State-bank circulation..					
Due to national banks..	2,280,617.15	2,191,660.20	1,784,251.77	1,184,974.72	1,014,920.21
Due to State banks....	2,549,617.27	2,500,465.48	1,927,496.87	1,073,390.53	890,665.68
Due to trust co.'s, etc..	224,690.83	367,524.10	207,992.96	148,529.49	107,222.25
Due to reserve agents..	114,311.60	116,283.51	44,660.72	99,095.45	123,588.71
Dividends unpaid.....	35,842.00	65,113.41	9,985.42	209,618.42	39,996.50
Individual deposits....	43,555,062.18	44,766,048.83	43,484,032.59	39,135,391.86	55,916,560.84
United States deposits..	1,526,438.50	1,209,730.53	579,288.80	393,796.17	608,724.64
Postal savings deposits..	47,602.83	48,465.95	53,074.55	52,905.32	56,663.19
Dep'ts U.S.dis. officers..	31,631.18	124,907.27	164,556.38		
Bonds borrowed.....	390,800.00	47,800.00	47,800.00		
U. S. bonds borrowed..				8,000.00	15,000.00
Other bonds borrowed..				21,800.00	181,800.00
Notes rediscounted.....	726,613.10	183,648.36	9,000.00	146,602.99	765,222.31
Bills payable.....	2,199,018.25	183,000.00	635,000.00	2,919,054.89	4,440,750.00
Reserved for taxes.....	35,931.62	14,235.03	32,280.09	54,521.26	45,394.45
Other liabilities.....	8,777.55	16,487.10	6,488.49	11,204.05	15,294.36
Total.....	79,904,962.61	78,429,569.78	75,802,070.12	72,563,370.56	73,355,269.94

(b) An example of balance sheets: liability side of banks in the state of Alabama from October 1913 to September 1914.

Figure II.7: Balance sheet original categories of the Abstract of Reports: banks in the state of Alabama from October 1913 to September 1914.

States	Panic, start	Panic, end	Reporting date	Time to start (days)
All (Major) - from Europe	18sep1873	30sep1873	26dec1873	99
NY, PA, NJ	13may1884	31may1884	20jun1884	38
NY	10nov1890	22nov1890	19dec1890	39
All (Major)	13may1893	19aug1893	12jul1893	60
IL, MN, WI	26dec1896	26dec1896	09mar1897	73
MA, NY	16dec1899	31dec1899	13feb1900	59
NY	27jun1901	06jul1901	15jul1901	18
PA, MD	18oct1903	24oct1903	17nov1903	30
All (Major) - from NY	12oct1907	30nov1907	03dec1907	52
NY	25jan1908	01feb1908	14feb1908	20
MA	12aug1920	02oct1920	08sep1920	27
ND	27nov1920	19feb1921	29dec1920	32
FL, GA	14jul1926	21aug1926	31dec1926	170
FL	08mar1927	26mar1927	23mar1927	15
FL	20jul1929	07sep1929	04oct1929	76
				Median 38.5

Table II.2: Banking panics chronology (in the sample period). The series is extracted from [Jalil \(2015\)](#). The first column reports the states in which the panic initially originated (**bold** font) and other “affected” states (normal font) where panics arose. The start and end dates of panics are obtained from the classification appendix of [Jalil \(2015\)](#) when possible or by reading the original sources listed in [Jalil \(2015\)](#). The fifth column reports the number of days elapsed between the start of a crisis and the first Abstract of Reports from the Comptroller of the Currency observed after the crisis.¹

¹There was a relatively minor panic in 1905 that stemmed in Chicago, Illinois. Starting on December 18, 1905 by the collapse of three banks (the Chicago National Bank, the Home Savings Bank and the Equitable Trust Company), these failures produced only mild consequence in Chicago and the United States due to the actions of the Chicago Clearing House Association. We omit the 1905 panic in Table II.2 since the first reporting after this crisis occurred in the first quarter of the next year. See the classification appendix of [Jalil \(2015\)](#) for more details.

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A Derivations and Proofs

Problem of Loanable Fund Allocation Deposit division of a bank in state n solves

$$\max_{\{M_{ni,t}(\tau)\}, D_{n,t}} \sum_{i=1}^N \int_0^1 R_{ni,t}^I(\tau) M_{ni,t}(\tau) d\tau - \underbrace{\rho_n^S(D_{n,t}) D_{n,t}}_{\text{Cost of loanable funds}},$$

subject to

$$\sum_{i=1}^N \int_0^1 T_{ni} z_{ni,t}(\tau) M_{ni,t}(\tau) d\tau = (D_{n,t})^\alpha.$$

The maximization problem thus becomes

$$\max_{\{M_{ni,t}(\tau)\}} \sum_{i=1}^N \int_0^1 R_{ni,t}^I(\tau) M_{ni,t}(\tau) d\tau - \rho_n^S \left(\underbrace{\left(\sum_{i=1}^N \int_0^1 T_{ni} z_{ni,t}(\tau) M_{ni,t}(\tau) d\tau \right)}_{=D_{n,t}} \right)^{\frac{1}{\alpha}} \cdot \left(\sum_{i=1}^N \int_0^1 T_{ni} z_{ni,t}(\tau) M_{ni,t}(\tau) d\tau \right)^{\frac{1}{\alpha}}. \quad (\text{A.1})$$

We observe that if $\rho_n^S(\cdot)$ is convex enough, even with $\alpha > 1$, the assumed economies of scale in allocating a large supply of deposits, the objective function in (A.1) becomes strictly concave in $\{M_{ni,t}(\tau)\}$, which guarantees the existence and uniqueness of the solution of optimization (A.1). The first order condition yields

$$R_{ni,t}^I(\tau) = T_{ni} \cdot z_{ni,t}(\tau) \cdot \left(\frac{1}{\alpha} \right) \rho_n^S(D_{n,t}) \underbrace{\left(1 + \frac{\rho_n^{S'}(D_{n,t}) D_{n,t}}{\rho_n^S(D_{n,t})} \right)}_{\equiv (\varepsilon_{n,t,D,\rho}^S)^{-1}} \cdot (D_{n,t})^{-(\alpha-1)},$$

where

$$\varepsilon_{n,t,D,\rho}^S \equiv \left[\frac{\rho_n^{S'}(D_{n,t}) D_{n,t}}{\rho_n^S(D_{n,t})} \right]^{-1} > 0.$$

represents the elasticity of deposit supply, proving (4).

Aggregation We use the following properties of the Weibull distribution. When $\{X_i\}_{i=1}^N$ are mutually independent, and X_i follows the Weibull distribution with λ_i as the scale

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parameter and κ as the shape parameter, i.e., $X_i \sim W(\lambda_i, \kappa)$:

Property 1 (Scalar Multiplication). $cX_i \sim W(c\lambda_i, \kappa)$ for some scalar c .

Property 2 (Moments). $\mathbb{E}((X_i)^n) = (\lambda_i)^n \Gamma\left(1 + \frac{n}{\kappa}\right)$ for $n \in \mathbb{R}$.

Property 3 (Minimum of $\{X_i\}$).

$$\min_i \{X_i\} \sim W\left(\left(\sum_{i=1}^N (\lambda_i)^{-\kappa}\right)^{-\frac{1}{\kappa}}, \kappa\right).$$

From (4) and using $z_{ni,t}(\tau) \sim W(1, \kappa)$, we obtain from Property 1 that

$$R_{ni,t}^I(\tau) = T_{ni} \cdot z_{ni,t}(\tau) \cdot \left(\frac{\rho_t}{\alpha}\right) \cdot (D_{n,t})^{-(\alpha-1)} \sim W\left(T_{ni} \left(\frac{\rho_t}{\alpha}\right) \cdot (D_{n,t})^{-(\alpha-1)}, \kappa\right),$$

which, with Property 3, leads to

$$R_{i,t}^I(\tau) = \min_n \{R_{ni,t}^I(\tau)\} \sim W(\Phi_{i,t}, \kappa),$$

where

$$\Phi_{i,t} = \left(\frac{\rho_t}{\alpha}\right) \cdot \left[\sum_{n=1}^N (T_{ni})^{-\kappa} (D_{n,t})^{\kappa(\alpha-1)}\right]^{-\frac{1}{\kappa}},$$

as presented in the main text.

Finally, with the help of Property 2, and the fact that $R_{i,t}^F(\tau) = R_{i,t}^I(\tau)$,

$$\begin{aligned} \mathbb{E}[R_{i,t}^F(\tau)^{-\beta}] &= \mathbb{E}[R_{i,t}^I(\tau)^{-\beta}] = (\Phi_{i,t})^{-\beta} \Gamma\left(1 - \frac{\beta}{\kappa}\right) \\ &= \left(\frac{\rho_t}{\alpha}\right)^{-\beta} \cdot \left[\sum_{n=1}^N (T_{ni})^{-\kappa} (D_{n,t})^{\kappa(\alpha-1)}\right]^{\frac{\beta}{\kappa}} \cdot \Gamma\left(1 - \frac{\beta}{\kappa}\right), \end{aligned}$$

from which we can obtain the expression for equilibrium loan amounts in state i as follows:

$$L_{i,t}^D = \mathbb{E}[R_{i,t}^F(\tau)^{-\beta}] \cdot \varepsilon_{i,t} = \left[\sum_{n=1}^N (T_{ni})^{-\kappa} (D_{n,t})^{\kappa(\alpha-1)}\right]^{\frac{\beta}{\kappa}} \left(\frac{\alpha}{\rho_t}\right)^\beta \Gamma\left(1 - \frac{\beta}{\kappa}\right) \varepsilon_{i,t} \quad \forall i,$$

proving equation (5).

Note: Lending in each state is linked to deposits in all other states. Especially with $\alpha > 1$, a decrease in $D_{n,t}$ leads to a drop in $L_{i,t}^D$.

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Log-linearization From equation (5),

$$\log L_{i,t}^D = \frac{\beta}{\kappa} \cdot \log \left(\sum_{n=1}^N (T_{ni})^{-\kappa} D_{n,t}^{\kappa(\alpha-1)} \right) + \beta \log \frac{\alpha}{\rho_t} + \log \Gamma \left(1 - \frac{\beta}{\kappa} \right) + \epsilon_{i,t},$$

which leads to

$$\begin{aligned} \check{L}_{i,t}^D &= \frac{\beta}{\kappa} \left(\sum_{n=1}^N \overbrace{T_{ni}^{-\kappa} D_{n,t}^{\kappa(\alpha-1)}}^{\equiv s_t} \right) \underbrace{-\beta \check{\rho}_t}_{\equiv s_t} + \epsilon_{i,t} \\ &= \frac{\beta}{\kappa} \sum_{n=1}^N \left(\underbrace{\frac{(T_{ni})^{-\kappa} D_n^{\kappa(\alpha-1)}}{\sum_{n=1}^N (T_{ni})^{-\kappa} D_n^{\kappa(\alpha-1)}}}_{\equiv \xi_{ni}} \right) (-\kappa \check{T}_{ni} + \kappa(\alpha-1) \check{D}_{n,t}) + s_t + \epsilon_{i,t} \\ &= \left(\underbrace{-\beta \sum_{n=1}^N \xi_{ni} \check{T}_{ni}}_{=\mu_i} \right) + \sum_{n=1}^N \left(\underbrace{\beta(\alpha-1) \xi_{ni}}_{\equiv \tilde{T}_{ni}} \right) \check{D}_{n,t} + s_t + \epsilon_{i,t} \\ &= \mu_i + s_t + \sum_{n=1}^N \tilde{T}_{ni} \check{D}_{n,t} + \epsilon_{i,t}, \end{aligned}$$

deriving equation (6).

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B Are Panics Exogenous or Correlated with Business Cycles?

To verify that the panics listed in Table II.2 (or [Jalil \(2015\)](#)) can be treated as exogenous—a key assumption for our estimation in Section 4.1—we estimate the following Granger causality regression. This test examines whether a panic functions as an exogenous shock or is correlated with business cycle conditions:

$$Panic_{i,t} = \mu_i + \mu_t + \sum_{l=1}^4 [\beta_l^D \Delta \log(D_{i,t-l}) + \beta_l^L \Delta \log(L_{i,t-l}) + \beta_l^B \Delta \log(Bank_{i,t-l})] + \varepsilon_{i,t},$$

where $Panic_{i,t}$ is a binary variable equal to one if state i experiences a banking panic in quarter t . We control for four lags of the growth rates of deposits, loans, and the number of banks in state i to account for business cycle conditions. Finally, μ_i and μ_t represent state and quarter fixed effects, respectively.

	1	2	3	4
Joint F-test, p-value	***	***	H_0	H_0
R-squared	0.37%	1.96%	0.07%	0.104%
All panics	X	X		
Minor panics			X	X
Individual fixed effects		X		X
Seasonal dummies		X		X

Table B.1: Granger causality test. We regress panic episodes on four lagged changes in deposits, loans, and the number of banks: $Panic_{i,t} = \mu_i + \mu_t + \sum_{l=1}^4 [\beta_l^D \Delta \log D_{i,t-l} + \beta_l^L \Delta \log L_{i,t-l} + \beta_l^B \Delta \log Bank_{i,t-l}] + \varepsilon_{i,t}$. The table reports the joint null $H_0 : \beta_l^D = \beta_l^L = \beta_l^B = 0$ for all l . An “X” indicates the inclusion of specific panic types or controls. Significance levels: *** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$, none when $p \geq 0.1$.

Table B.1 presents the results of the Granger causality test under the joint null $H_0 : \beta_l^D = \beta_l^L = \beta_l^B = 0$ for all $l = 1, \dots, 4$. Columns 1 and 2 report results using nationwide *major* panics from [Jalil \(2015\)](#), while Columns 3 and 4 use regional *minor* panics. The null is rejected for major panics (with and without fixed effects) but not rejected at the 10% level for the minor panics.

Because major panics, by their nationwide nature, offer little variation for identifying spatial transmission, we exclude them from our analysis as explained in Section 2. Accord-

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ingly, in Sections 4.1 and 4.2 we treat the minor panics of [Jalil \(2015\)](#) as exogenous.

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C Robustness Checks

This section examines the robustness of the empirical results presented in Section 4 with respect to variations in the factorization used in equation (7) to capture the spatial propagation of panics. We consider two alternatives: a more restrictive definition of panics and the inclusion of deposit volume in the origin panic states to account for potential scale effects.

Panic Dummies for Origin States Only In regression (9), we initially set $Panic_{i,t} = 1$ for any state i experiencing a panic in quarter t , regardless of its origin (e.g., for the 1884 panic in Table II.2, $Panic_{NY,1884Q2} = Panic_{PA,1884Q2} = Panic_{NJ,1884Q2} = 1$, with 1884Q2 denoting the second quarter of 1884). For robustness, we re-estimated (9) assigning $Panic_{i,t} = 1$ only for the origin state of each panic (see Table II.2 for the list provided by [Jalil \(2015\)](#)). The results, presented in Online Appendix C.1, are nearly identical to our baseline estimates. We conclude that our findings on the spatial transmission of panic shocks are robust to alternative definitions of the panic dummy.

Deposit Size Effects In our baseline specification (9), we abstract from the possibility that panics in states with larger financial markets have a greater impact on other states. To account for such size effects, we modify the regression by controlling for lagged deposit shares:

$$y_{i,t+h} = \eta_{i,h}^y + s_{t,h}^y + \sum_{j=1}^5 \theta_{j,h}^y F_{i,t}^j + \sum_{l=1}^L \beta_{l,h}^y \mathbf{X}_{i,t-l} + \epsilon_{i,t+h}, \quad h = 1, \dots, H, \quad (\text{C.1})$$

where the factors are defined as:

$$\begin{aligned} F_{i,t}^1 &= \sum_{n=1}^N \textcolor{blue}{Panic}_{n,t} & F_{i,t}^3 &= \sum_{n=1}^N \text{Neighbor}_{ni} \cdot \textcolor{blue}{Panic}_{n,t} \\ F_{i,t}^2 &= \sum_{n=1}^N \log(Distance_{ni}) \cdot \textcolor{blue}{Panic}_{n,t} & F_{i,t}^4 &= \sum_{n=1}^N \text{Own}_{ni} \cdot \textcolor{blue}{Panic}_{n,t} \\ \textcolor{red}{F}_{i,t}^5 &= \underbrace{\sum_{n=1}^N \log\left(\frac{D_{n,t-1}}{D_{t-1}}\right)}_{\text{New control}} \cdot \textcolor{blue}{Panic}_{n,t} \end{aligned}$$

with $D_{t-1} = \sum_n D_{n,t-1}$. Here, $\eta_{i,h}^y$ and $s_{t,h}^y$ denote state and seasonal fixed effects, and $\mathbf{X}_{i,t-l}$ includes four lags of the factors $F_{i,t}^j$ and lags of the dependent variable $y_{i,t}$. Online

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Appendix C.2 replicates the empirical analysis of Section 4 using this alternative factorization. The results are very similar to our original estimates, indicating that the size effect in the spatial propagation of panics is limited.

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C.1 Panic Dummies for Origin States Only

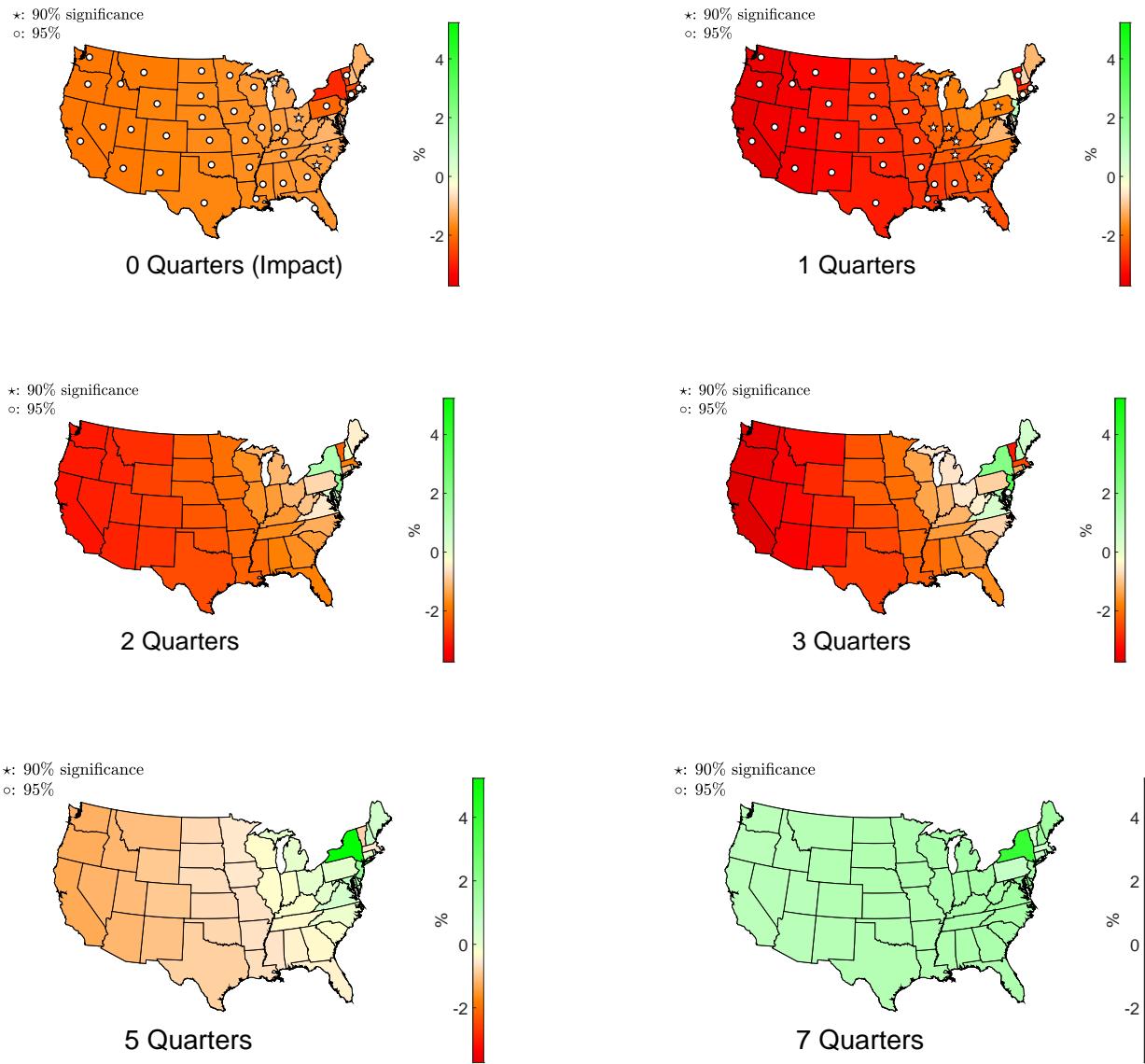


Figure C.1: Impulse-response of bank deposits to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. \circ $p < 0.05$, $\star p < 0.1$. Here, we assume $Panic_{i,t} = 1$ only for the origin state i where each panic listed in Table II.2 (Jalil, 2015) is known to have originated.

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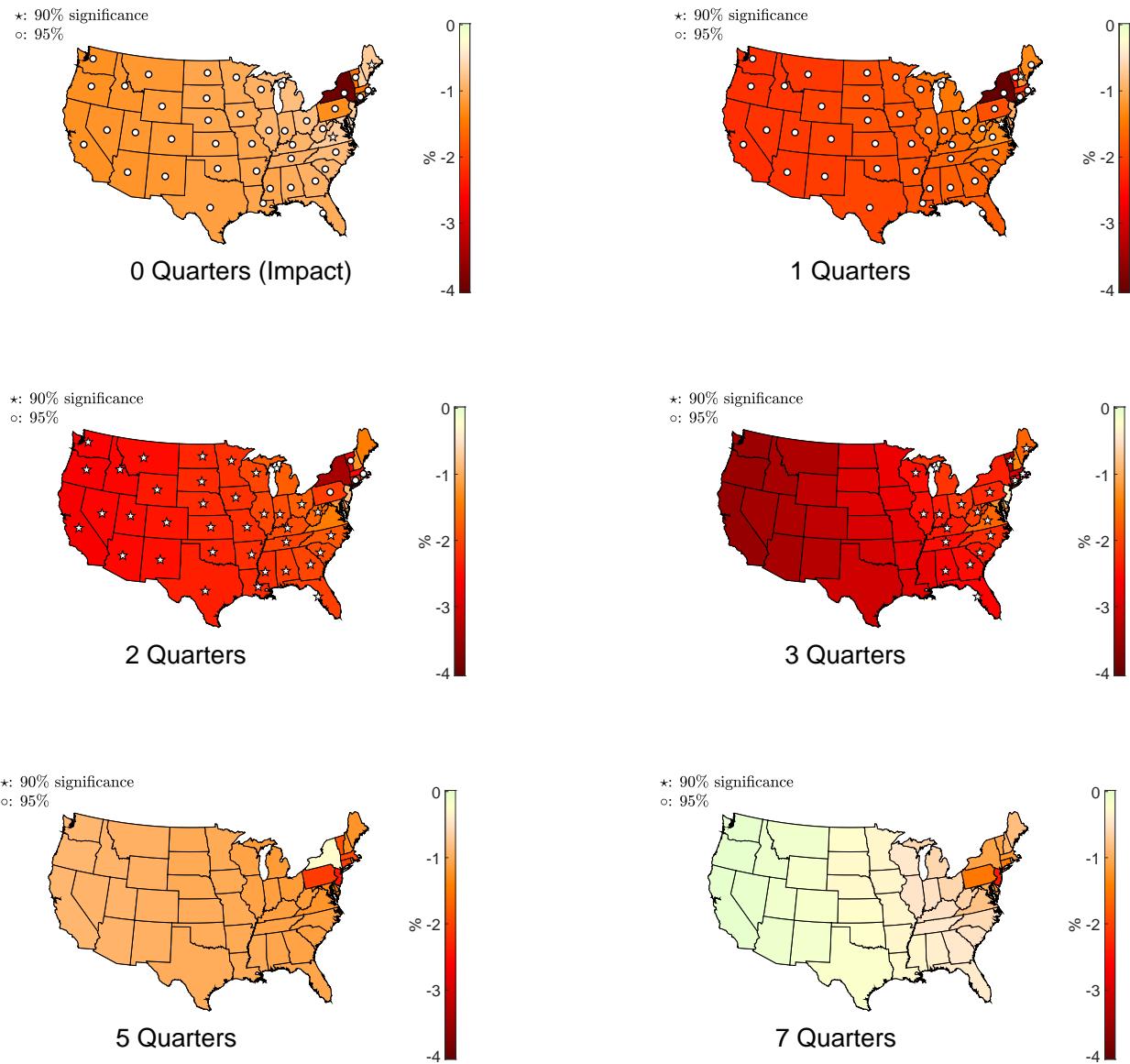


Figure C.2: Impulse-response of bank loans across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we assume $Panic_{i,t} = 1$ only for the origin state i where each panic listed in Table II.2 (Jalil, 2015) is known to have originated.

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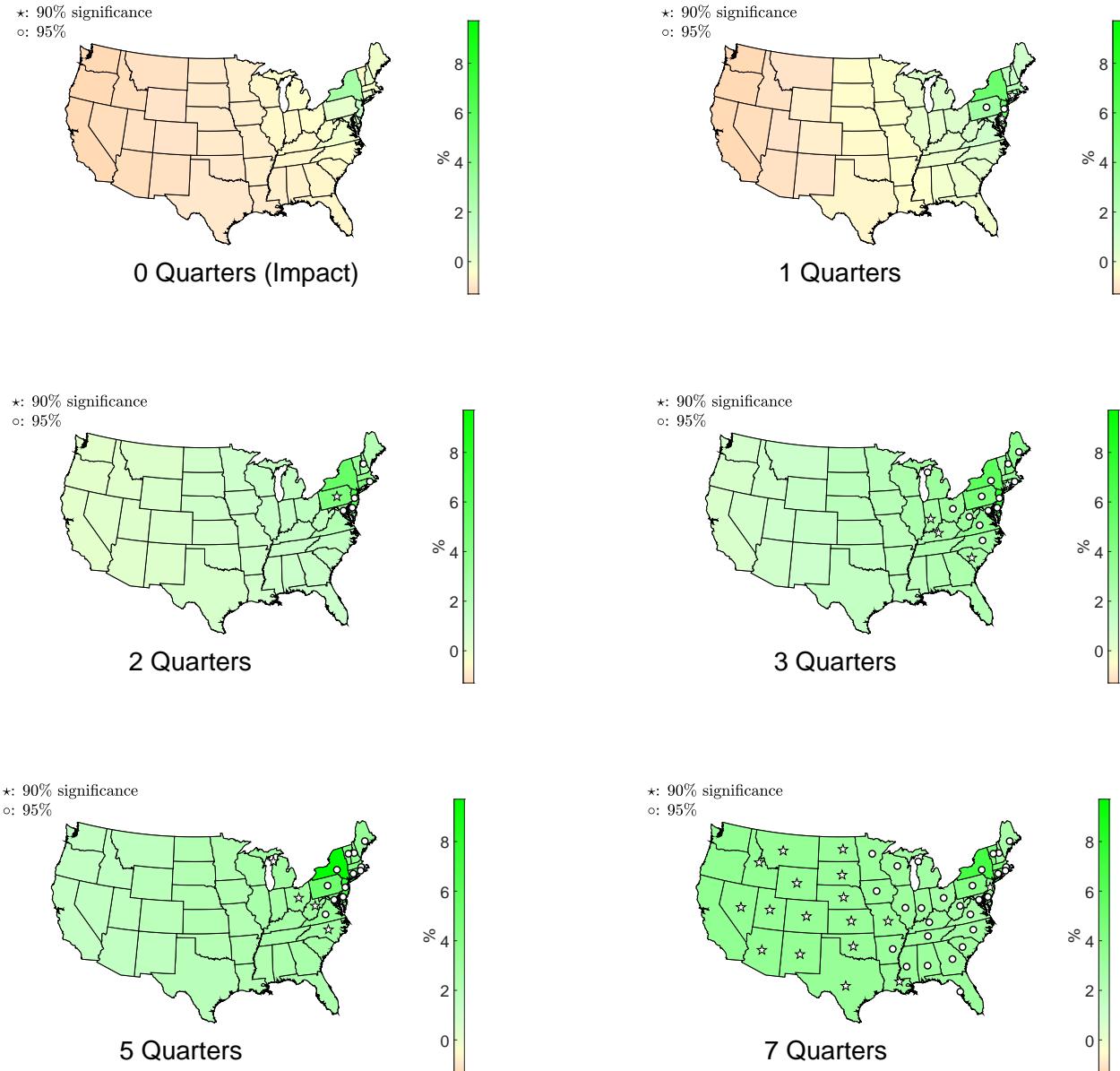


Figure C.3: Impulse-response of liquidity ratios across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we assume $Panic_{i,t} = 1$ only for the origin state i where each panic listed in Table II.2 (Jalil, 2015) is known to have originated.

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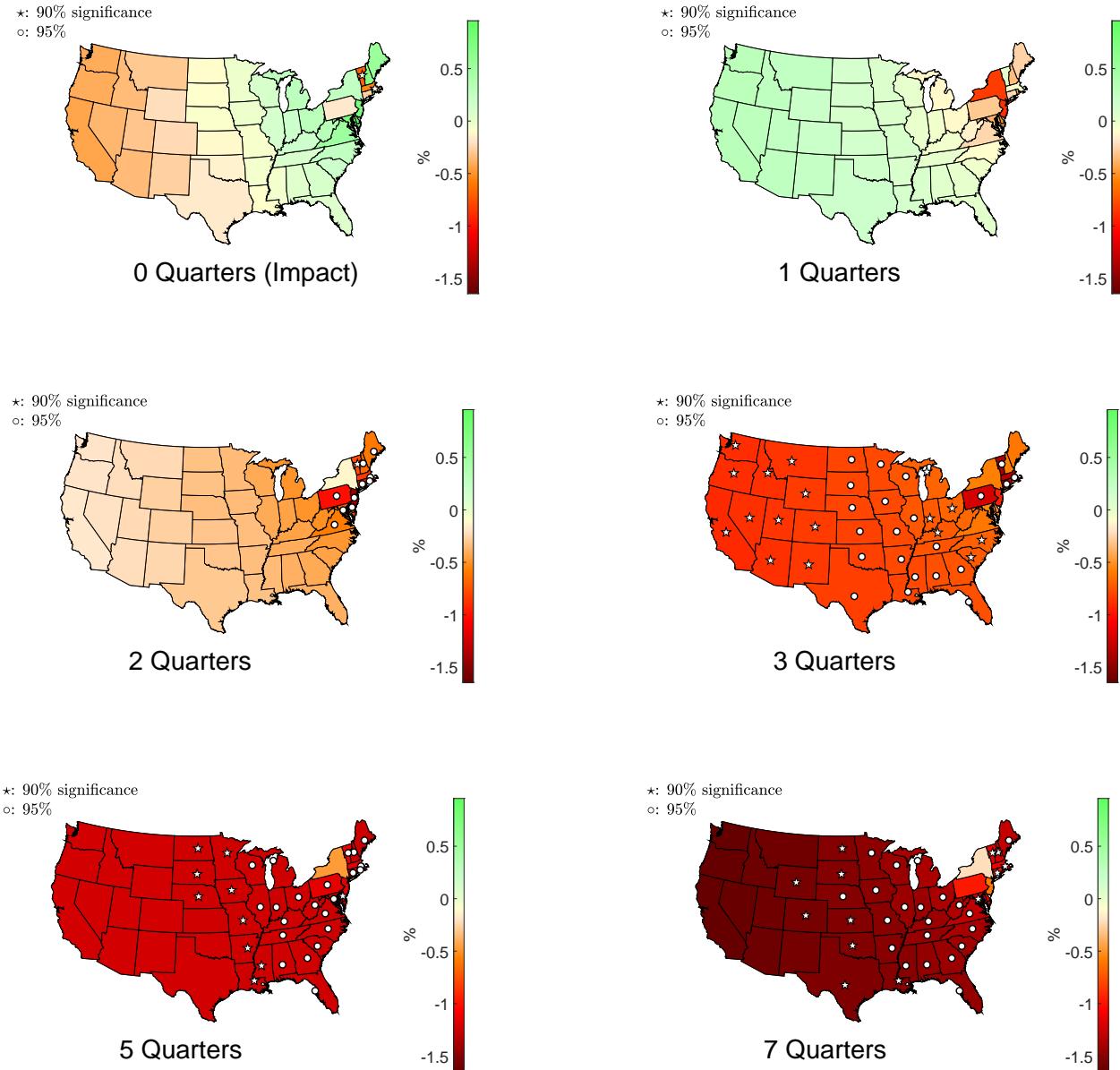


Figure C.4: Impulse-response of bank capital across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we assume $Panic_{i,t} = 1$ only for the origin state i where each panic listed in Table II.2 (Jalil, 2015) is known to have originated.

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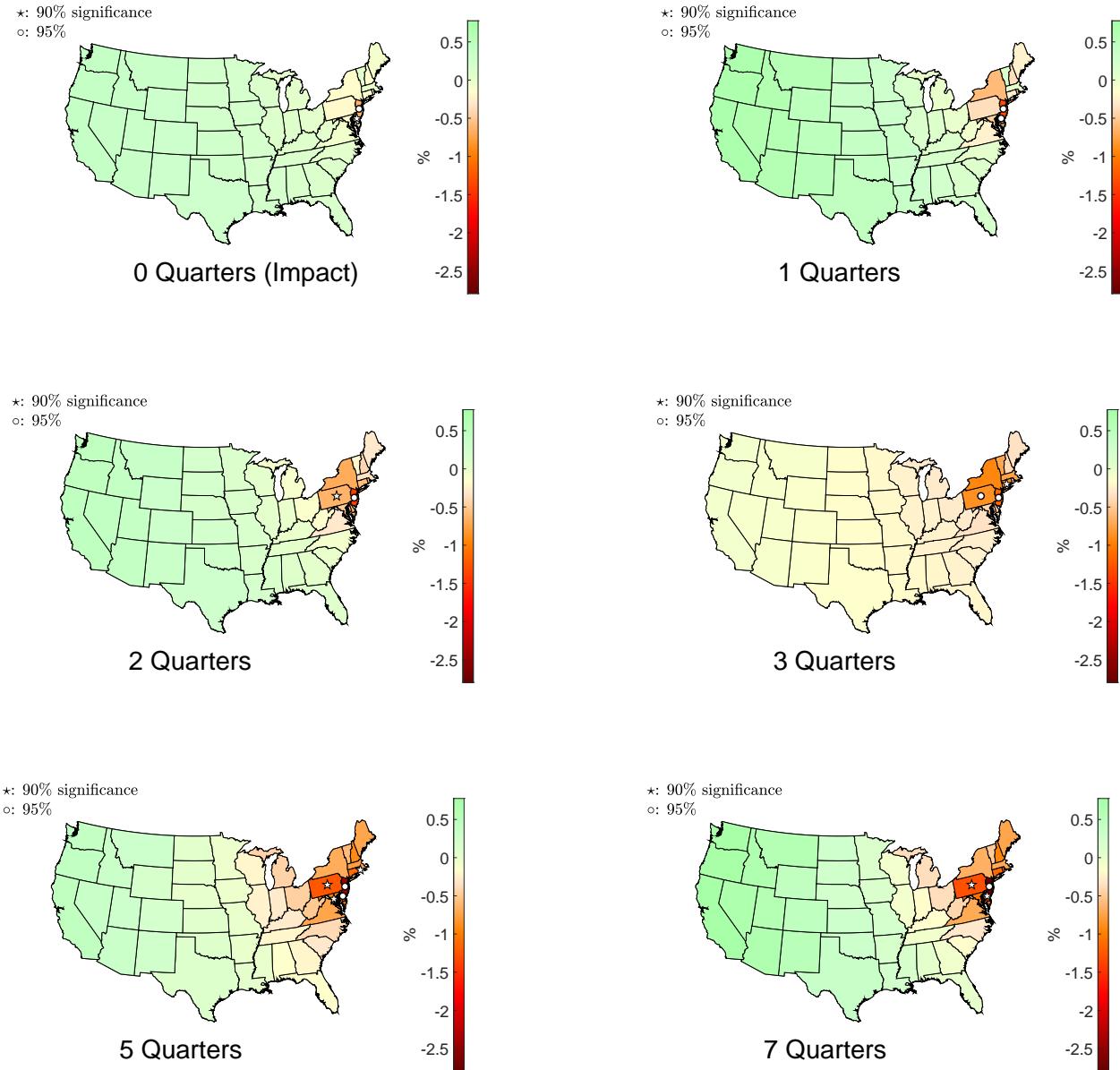


Figure C.5: Impulse-response of the number of banks across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we assume $Panic_{i,t} = 1$ only for the origin state i where each panic listed in Table II.2 (Jalil, 2015) is known to have originated.

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C.2 Deposit Size Effects

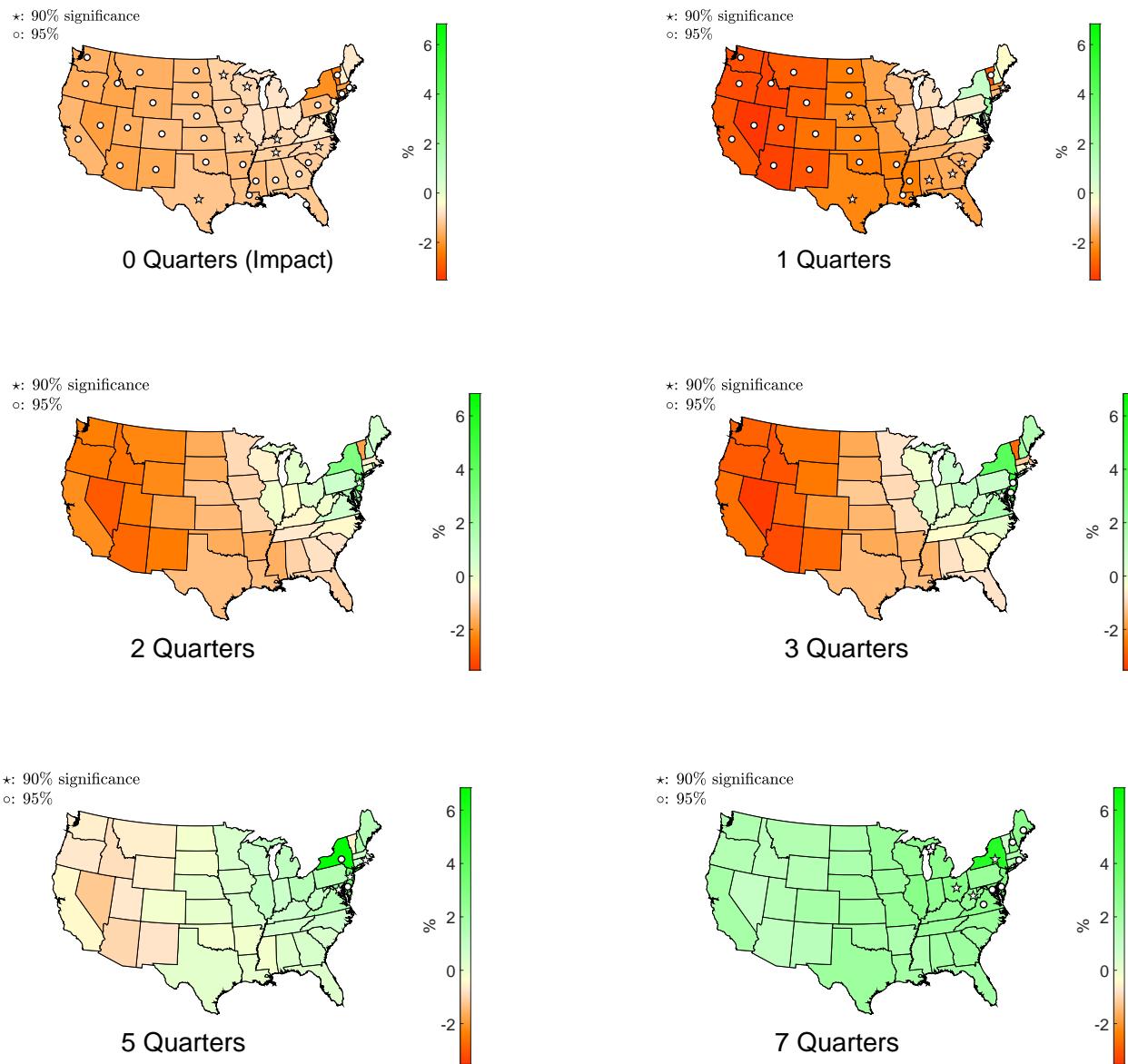
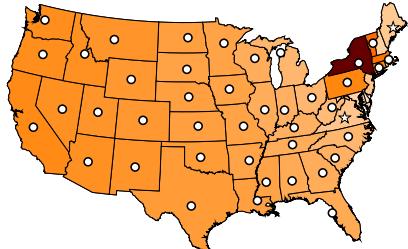


Figure C.6: Impulse-response of bank deposits to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. Here, we control the relative size of deposits in the previous quarter interacted with panic dummies.

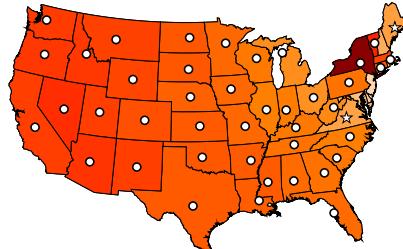
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*: 90% significance
o: 95%

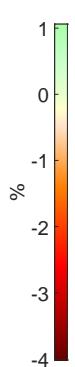


0 Quarters (Impact)

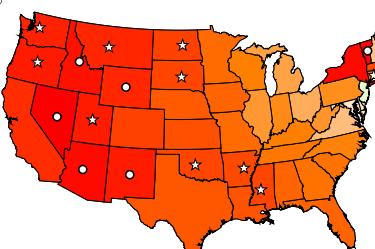
*: 90% significance
o: 95%



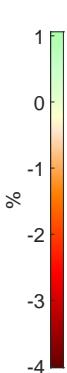
1 Quarters



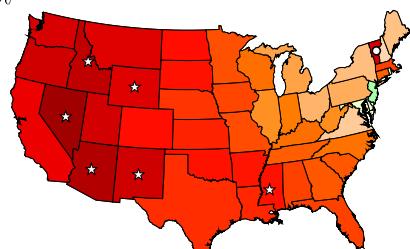
*: 90% significance
o: 95%



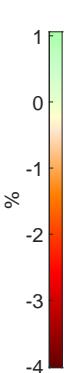
2 Quarters



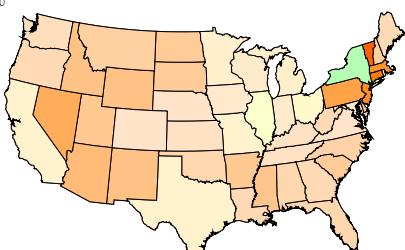
*: 90% significance
o: 95%



3 Quarters



*: 90% significance
o: 95%



5 Quarters



*: 90% significance
o: 95%



7 Quarters

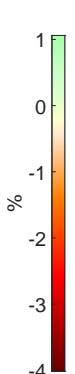


Figure C.7: Impulse-response of bank loans across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we control the relative size of deposits in the previous quarter interacted with panic dummies.

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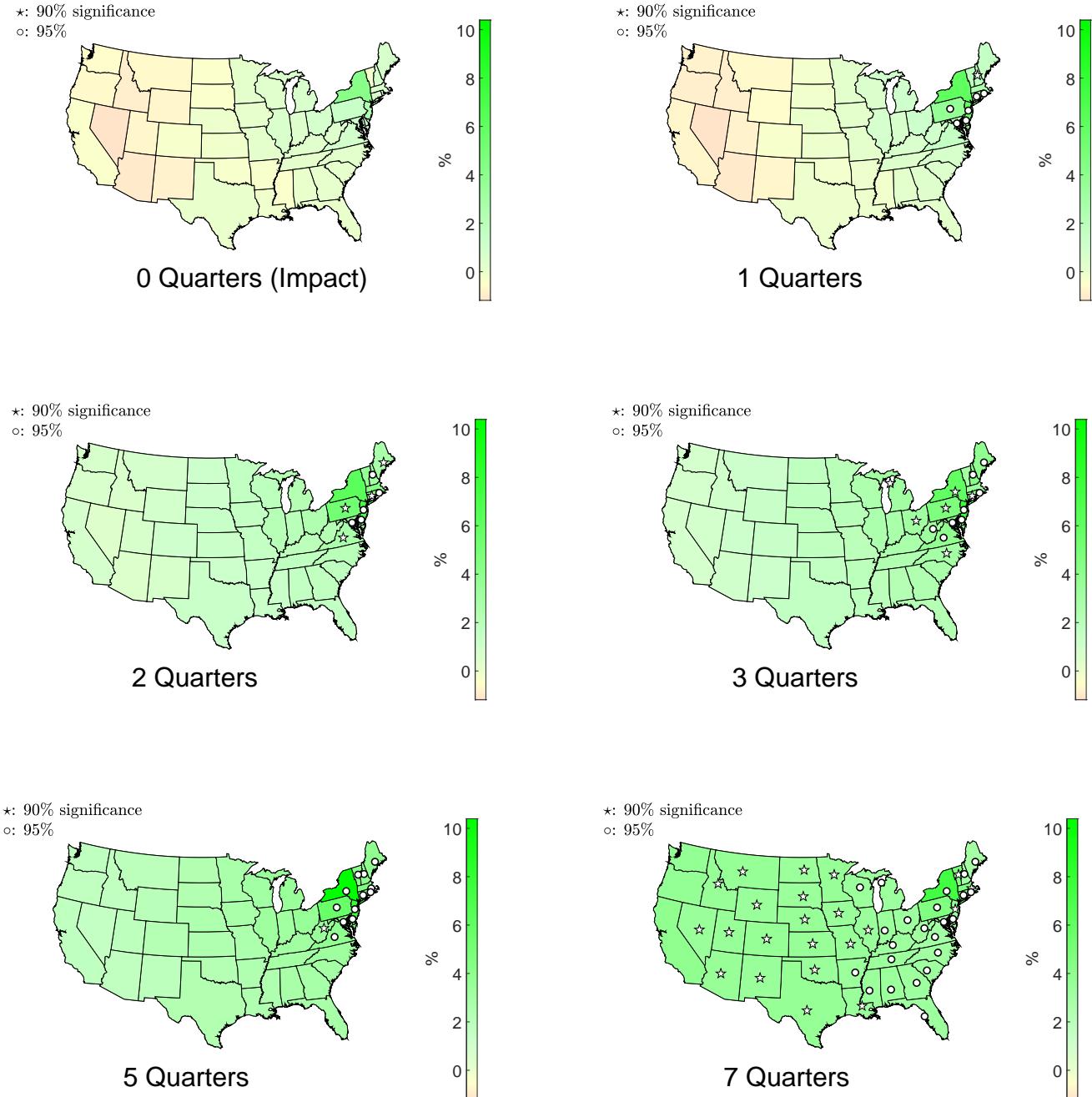


Figure C.8: Impulse-response of liquidity ratios across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we control the relative size of deposits in the previous quarter interacted with panic dummies.

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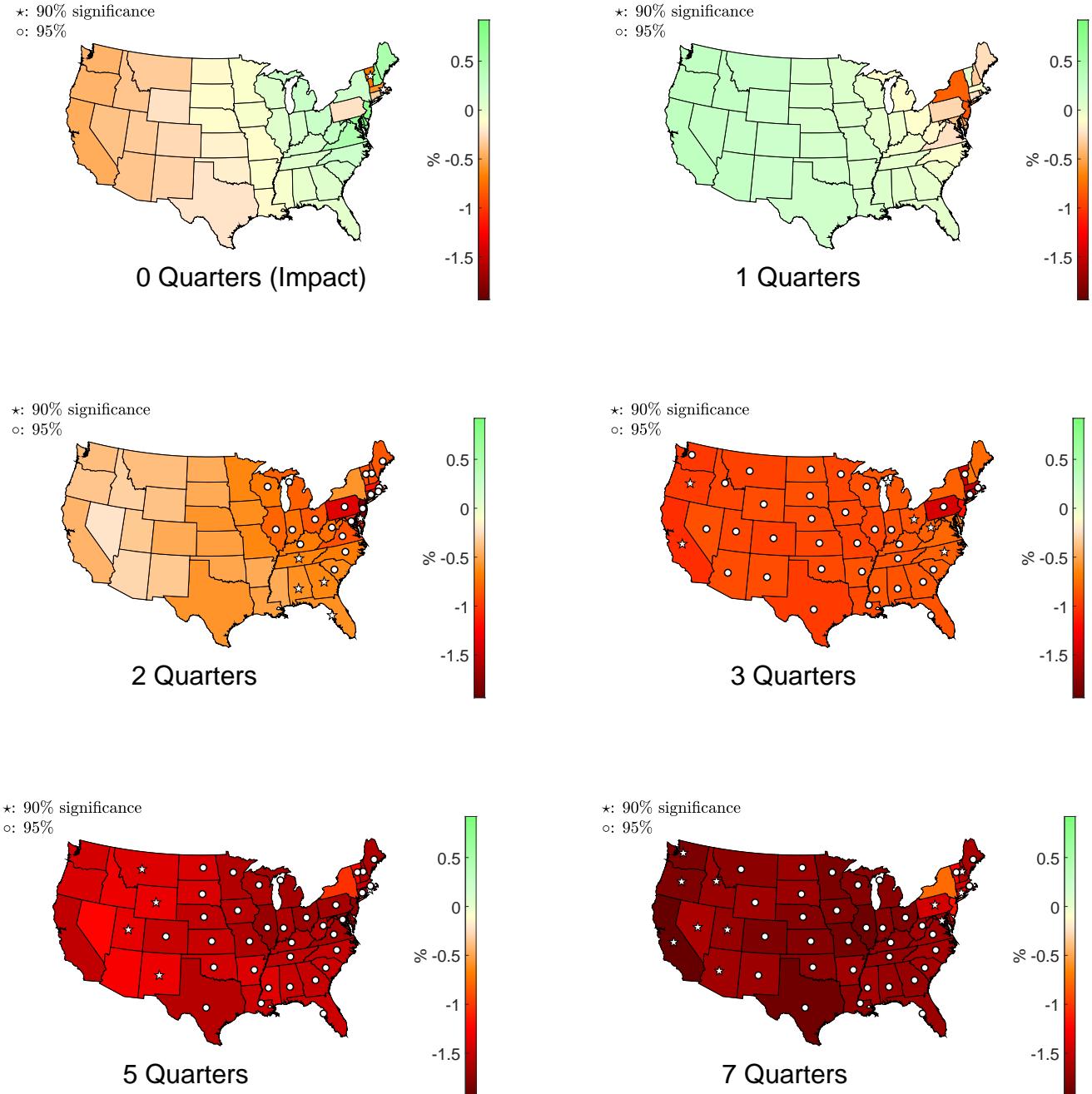


Figure C.9: Impulse-response of bank capital across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we control the relative size of deposits in the previous quarter interacted with panic dummies.

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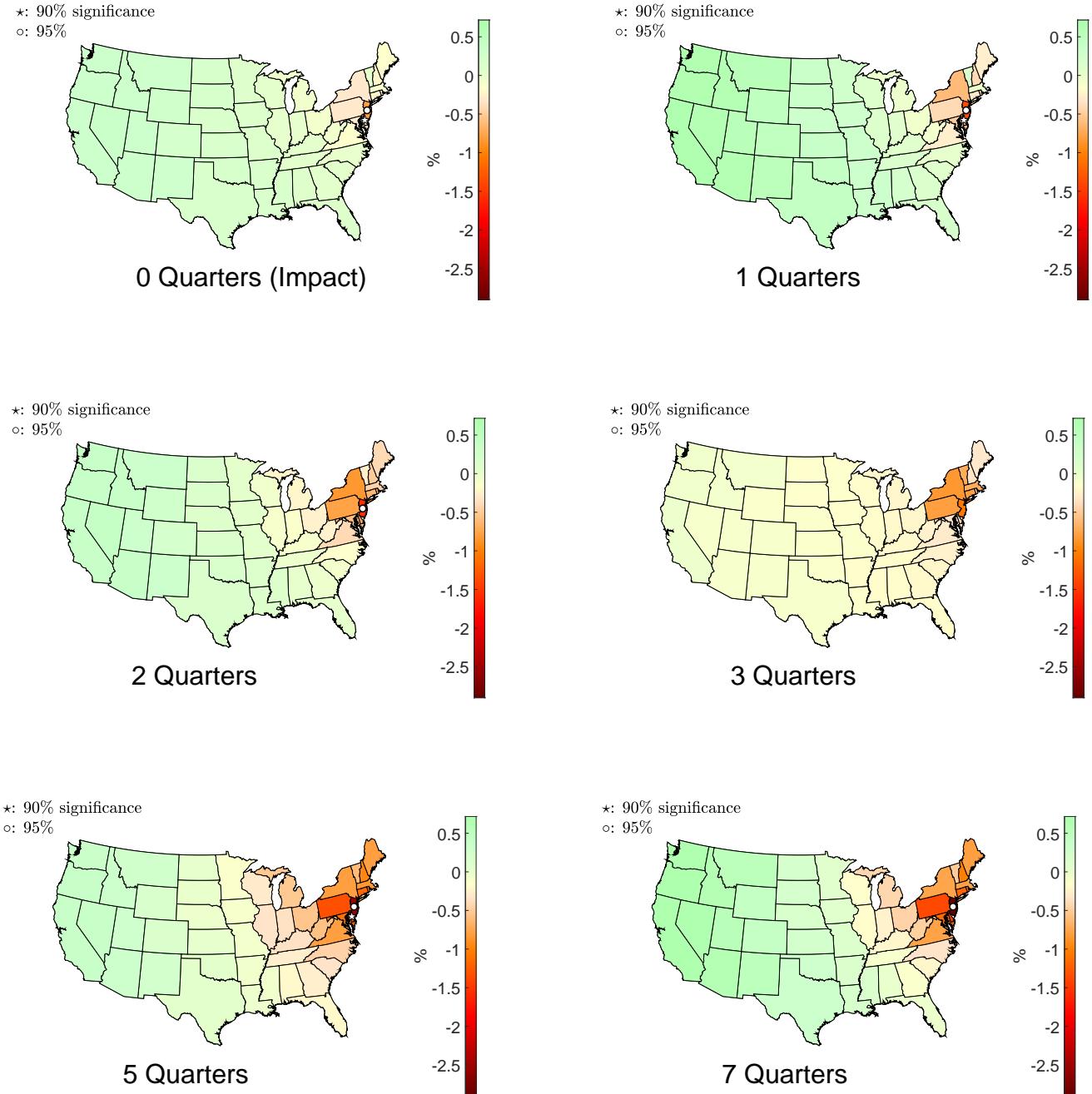


Figure C.10: Impulse-response of the number of banks across states to a panic from New York. Right bar reports graph estimates color scale. P-values constructed using Driscoll-Kraay standard errors. $\circ p < 0.05$, $\star p < 0.1$. Here, we control the relative size of deposits in the previous quarter interacted with panic dummies.

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References

- Jalil, Andrew J.** “A new history of banking panics in the United States, 1825–1929: Construction and implications,” *American Economic Journal: Macroeconomics*, 2015, 7 (3), 295–330.