NBER WORKING PAPER SERIES

VENTURE CAPITAL AND STARTUP AGGLOMERATION

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Working Paper 29211
http://www.nber.org/papers/w29211

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2021, Revised June 2024

We are grateful to Antoinette Schoar (the editor), an associate editor, and two anonymous referees for many constructive and illuminating comments and suggestions, which immensely helped us improve the paper. We also thank Ferhat Akbas, Foly Ananou (discussant), Ehsan Azarmsa, Dominique Badoer, Oleg Bondarenko, Joan Farre-Mensa, Zhaoyang Gu (discussant), Song Ma, Dermot Murphy, Ramana Nanda, Manju Puri and Tengjia Shu as well as seminar participants at Renmin University of China, University of Illinois at Chicago, Office of the Comptroller of the Currency (OCC), the 34th Australasian Finance and Banking Conference, the Fourteenth Annual Conference on Innovation Economics for helpful conversations and commentary, and the organizers of the 2022 Western Finance Association (WFA) Meetings and 2022 Financial Intermediation Research Society (FIRS) Conference for accepting our paper. A previous version of this paper was circulated under the title \Venture Capitalists' Access to Finance and Its Impact on Startups." The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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JEL No. G21,G23,G24,K22,L26

ABSTRACT

The paper studies venture capital's (VC) role in the geographic clustering of high- growth startups. We exploit a rule change that disproportionately impacted U.S. regions that historically lacked VC financing via a restriction of banks to invest in the asset class. A one-standard-deviation increase in VCs' exposure to the rule led to a 20% decline in fund size and a 10% decrease in the likelihood of raising a follow-on fund. Startups were not wholly cushioned: financing and valuations declined. Startups also moved out of impacted states after the rule change, likely exacerbating existing geographic disparity in entrepreneurship.

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Data on banks investment in VC is available at https://github.com/michaelewens/Banks-In-VC

Entrepreneurship and innovation in the U.S. are geographically concentrated (Chen, Gompers, Kovner, and Lerner, 2010; Chatterji, Glaeser, and Kerr, 2014; Chattergoon and Kerr, 2022). The concentration of entrepreneurial activities has important implications for economic performance and regional development, which has motivated many federal and local policies (Saxenian, 1994; Lerner, 2012). These policies include place-based programs, direct investments, grants, subsidized loans, education, and tax breaks (e.g., Chatterji et al., 2014). Effectively targeting these policy solutions demands a full accounting of the *drivers* of geographic concentration. While various explanations, including input sharing (Marshall, 1890), labor market pooling (Saxenian, 1994), knowledge spillovers (Jaffe, Trajtenberg, and Henderson, 1993), have been studied, one that remains under-explored is the availability of entrepreneurial finance. This paper investigates the role of the supply of risk capital – as measured by venture capital (VC) – in driving the spatial concentration of high-growth entrepreneurship in the U.S.

VC investors and their investment activity exhibit similar concentration as entrepreneurial firms. For example, VC funds based in California (CA), Massachusetts (MA), and New York (NY) accounted for 92% of the capital raised in the U.S. in 2018 (the end of our sample period), and startups in these three states received almost 80% of the total venture capital invested in the same year (NVCA, 2019). Given these states' high concentration of VC activities, they define our "VC hubs."[1] Anecdotal evidence suggests that the lack of early-stage funding outside VC hubs plays a part in explaining financing constraints faced by high-growth startups in those regions and has led to investment opportunities going unfunded.[2] However, identifying risk capital supply's role in explaining the agglomeration of high-growth startups is challenging. With strong preferences to invest locally (Chen et al., 2010), venture capital

[1] Various VC metrics such as capital under management, commitments, and total VC investments over different periods consistently show that CA, MA, and NY are the top three VC states. For example, in 2013, the year before the implementation of the Volcker Rule, capital under management in the top three states was $94,076.6, $32,636.6, and $19,480.4 million, while the fourth state CT had $5,818.1 million (Pitchbook).

[2] See, e.g., `https://hbr.org/2013/10/dont-build-your-startup-outside-of-silicon-valley`

investors could concentrate in regions simply because they follow capital demand, i.e., they invest where the high-growth startups are located.

Uncovering the role of the venture capital supply in startup clustering also requires understanding how the capital is intermediated. As the primary financiers of innovative startups, VCs invest on behalf of institutional investors (i.e., limited partners or LPs) from which they raise capital. This financial intermediation implies that VCs' own investors could influence capital supply and geographic allocation. Specifically, as documented by prior literature and confirmed by our analyses, different types of LPs are unequally distributed across the U.S. while exhibiting varying home bias (e.g., Hochberg and Rauh, 2013). These facts demonstrate a channel where some LPs are restricted in supplying capital to VCs, which can negatively affect VCs across regions. These restrictions, in turn, can impact startup financing by geographies and, ultimately, the regional inequality in startup distribution. Importantly, this channel only exists if either LP capital or VC fails to move freely across geographies.

Connecting local capital supply to startup clustering requires an experiment that randomizes the former across regions while allowing one to track startups' capital raising and migration choices across regional clusters. Because we are interested in some regions' persistent under-representation in high-growth entrepreneurship and innovation, this exogenous variation should also impact capital in high-financing constraint geographies (i.e., those outside the major capital centers). This experiment would allow the identification of the role of capital in explaining this under-representation. As alluded to above, one potential source for such variation follows from the nature of VC financial intermediation: changes in the supply of their limited partners. Indeed, an extensive literature uses shifts in capital available from pension funds to explore the causal effects of changes to local VC financing (e.g., Kortum and Lerner, 2000; González-Uribe, 2020). Similarly, we approximate the ideal experiment by exploiting a 2013 legal change restricting a narrow set of limited partners predominantly outside the VC financing clusters.

What might happen to VC and startup activities in the face of restrictions on LP capital? In a frictionless external finance market, VCs would find substitutes for the lost LPs, and researchers would observe no change. Recent experiences suggest this is a sensible prior, as VC and private equity (PE) fundraising have experienced significant growth in the last twenty years, while deregulation of the private markets has accelerated (Ewens and Farre-Mensa, 2020). Alternatively, VC fundraising in certain regions or industries may be constrained. For example, LP investing exhibits home bias, and restricting LPs could negatively impact local VCs based in the same regions. Next, a market focus on established funds may also lead to constraints for some VCs. Though the total capital VCs raised has grown significantly in the past decade, only less than 20% went to first-time VC funds.[3] Therefore, less LP allocation to VC could worsen certain VCs' fundraising ability and startups' access to capital.

We test these hypotheses using a change in U.S. banking regulation from the Volcker Rule. Considered a legal overreach by many, the Volcker Rule (implemented in 2014 and effectively ended in mid-2019) prohibited banking entities from investing in or sponsoring venture capital funds.[4] As shown by Lerner, Schoar, and Wongsunwai (2007) and confirmed using banks' regulatory filings, banks as LPs are important sources of capital, providing between 4-8% of capital to VC funds in the years before the Volcker Rule passage. Based on administrative data reported by banks, our estimates also find a significant variation in states' reliance on banks for the supply of capital before the Volcker Rule. Banks in Midwestern states provided as much as 25% of capital to VC funds, while banks provided less than 5% of capital in VC hub states such as California. This differential reliance translates into unequal exposure to the Volcker Rule's impact by state. Indeed, the NVCA, U.S. venture capital industry's trade association, argued for just this view[5]:

[3] Pitchbook-NVCA 2020 Q4 report.

[4] Community banks (with less than $10 billion in assets and total trading assets and liabilities of no more than 5% of total consolidated assets) were exempt from the relevant sections of the rule after July 2019. The section was rescinded in October 2020. Credit unions regulated by the National Credit Union Administration (NCUA) are not subject to the Volcker Rule.

[5] NVCA letter to federal regulators "Proposed Revisions to Prohibitions and Restrictions on Proprietary

> The loss of banking entities as limited partners in VC funds has had a disproportionate impact on cities and regions with emerging entrepreneurial ecosystems – areas outside of Silicon Valley and other traditional technology centers. The more challenging reality of venture fundraising in these areas of the country tends to require investment from a more diverse set of limited partners.

Although not explicitly part of the rule, it thus has the potential to impact the high-financing constraint areas from our idealized experiment. We confirm that the rule change had the intended impact on banks' investments in VC. The number of banks holding VC investments decreased by more than 40% from 2013 to 2018 after the Volcker Rule change.

Our empirical strategy exploits the fact that the rule change unintentionally impacts regions of the U.S. differently depending on banks' roles as LPs. We first document that VCs in the Midwestern, Southern, and non-VC-hub states had higher bank exposure than other states before the Volcker Rule change. Next, differential exposure to the rule change based on bank LP activity will only manifest itself in VCs' fundraising when we incorporate one other well-documented fact: home bias by limited partners. Hochberg and Rauh (2013) and subsequent papers using LP supply shocks as instruments (e.g., González-Uribe, 2020) show that the largest LP class in the VC industry–pension funds–exhibits an abnormal propensity to invest in same-state VC funds. A similar analysis in this paper also indicates that other major LP types, including banks, have significant in-state overweighting in VC funds. Suppose the Volcker Rule change was unexpected and the pre-2014 distribution of banks as LPs was not experiencing differential trends across regions. In this case, we can identify the causal impact of the rule change using a difference-in-differences estimate.

Our analysis combines several datasets for the 2010–2018 sample period. The Call Reports and FR Y-9Cs form the basis of our data on banks' exposure to VC funds. Although we cannot directly observe a bank's position in a VC fund, these reports include "venture capital revenue," which consists of market value adjustments, gains, and losses of banks'

Trading and Certain Interests in, and Relationships With, Hedge Funds and Private Equity Fund", April 2020.

venture capital investments. Two hundred eighty-six unique banking entities have reported venture capital revenue in 48 states from 2001 (the first year venture capital revenue data are available) to 2013 (the last year before the Volcker Rule change) in our sample. We aggregate the data at the state level to create the primary bank exposure variable. VentureSource and Pitchbook provide data on venture capital fundraising, startup financing, and other startup outcomes. The VC sample includes 1,617 VC funds and 11,048 VC-backed startups. We also rely on a combination of Form D filings and VentureSource data to track startup address changes and measure the cross-state migration of high-growth startups. We identified 1,700 startups that have ever moved to a different state over our sample period.

VC funding changes in several ways in states more exposed to the rule change. Two extensive margins exhibit declines: the number of VC funds closed and the probability that a pre-Volcker VC raised a follow-on fund. On the intensive margin, we find that total VC funds raised in the state-year falls, while funds that do successfully close are smaller (a one-standard-deviation increase in VCs' exposure to the loss of banks as LPs leads to a 22% decline in fund size). These results show that the treated VCs – those headquartered outside the major VC centers – faced financial constraints and struggled to find alternative limited partners after the Volcker Rule. The declines also speak to a point raised in the last report on the Volcker Rule (Federal Register, 2014):[6]

> To the extent that banking entities may reduce their investments in venture capital funds that are covered funds, the potential funding gap for venture capital funds may also be offset, in whole or in part, by investments from firms that are not banking entities and thus not subject to section 13's restrictions.

Consistent with the comments cited in the report, our results show that VC funds in the impacted states found their "funding gap" only filled "in part."

We next investigate whether VC financial constraints spill over to local high-growth startups. Entrepreneurs can supplement lower local (e.g., state) capital availability in a

[6] See Federal Register, Vol. 79, No. 21 January 31, 2014, Book 2 of 2, Pages 5535–6076.

world with perfect substitutes with alternatives such as friends and family financing, angels, bank debt, government grants, or other private equity. However, if these capital sources are instead complementary to VC or already exhausted pre-2014, then the decline in VC will be unfilled. We find that startups raise 7% smaller financing rounds and are more likely to raise other sources of capital before VC financing. Financed startups also have 9% lower pre-money valuations with no change in VC equity stakes. Thus, firm valuations fall, with both the financier and founder suffering value loss. The changes in valuation mirror the findings in Gompers and Lerner (2000), which shows that VC inflows create demand pressure and valuation changes. These results indicate that VC financial constraints manifest as worse financing conditions for local startups and change the composition of financed startups.

Our final analysis investigates whether decreases in the supply of local VC funding impact high-growth startups' migration to places with more abundant capital supply (i.e., VC hubs). If so, we will have documented a channel – the availability of venture capital – for startup clustering. Any shifts after the Volcker Rule would thus exacerbate the agglomeration of U.S. high-growth startups. We find evidence that startups respond in this way. Among startups that move to California, the number of startups originating from one of the treated states with high bank exposure increases by more than 30% after the passage of the Volcker Rule. A difference-in-differences estimation reveals that startups in states with higher bank exposure are more likely to move to CA, or VC hubs (CA, MA, and NY) in general, but not to non-VC hubs. Thus, the rule change impacted the relocation of startups across states, suggesting that the supply of venture capital explains some of the observed startup agglomerations.

The negative impact on startups we documented (regarding financing and migration) suggests that non-local VCs are not filling the financing gap created by a local VC contraction. One explanation for this behavior is information asymmetry. Here, when investors consider a geographically distant startup investment, they require a local VC's informational advantage about the investment opportunity. Consistent with this hypothesis, we show that the larger the distance between a VC and a startup in its portfolio, the more likely the investment includes a local VC investor. Thus, startups faced with a depleted local VC supply after the Volcker Rule cannot simply rely on distant (untreated) VCs to fill the gap.

Related literature

Our paper first contributes to the literature on venture capital and entrepreneurship agglomeration. Existing literature documents that venture capital is geographically concentrated and invests proximately, and this local proximity also leads to better investment outcomes for investors due to the unique nature of early-stage investing, such as high information asymmetry (e.g., Cumming and Dai, 2010; Chen et al., 2010; Bernstein, Giroud, and Townsend, 2016; Krishnan and Nguyen, 2020). Meanwhile, a large literature shows that entrepreneurship and innovation are highly concentrated, and there are many potential drivers of this phenomenon, such as input sharing, labor market pooling, and knowledge spillovers (e.g., Carlino and Kerr, 2015). Our study connects the above two pieces of literature by identifying the unique role of venture capital in promoting startup agglomeration. There is also related work that studies the impact of local venture capital availability on entrepreneurship at the regional level. In an early unpublished work, Mollica and Zingales (2007) use the total assets of local and state pension funds as an instrument for VC investments and show that VC investments have a positive effect both on the production of patents and on the creation of new businesses at the Bureau of Economic Analysis (BEA) level. Samila and Sorenson (2011) use endowment LPs' returns as an instrument for venture capital supply, and find that increases in VC supply positively affect firm starts, employment, and aggregate income at the MSA level. Unlike these existing studies, our paper leverages a plausibly exogenous shock on the supply of venture capital and eliminates the ex-ante matching effects between capital supply and demand by providing firm-level evidence on existing startups' cross-state relocation to VC hubs.

Our paper is also directly related to a growing literature on startup migration. For example, Duranton and Puga (2001) find that new products are more likely to be developed in diversified cities, and after finding their ideal production process, firms may migrate to specialized cities for mass production to reduce costs. Guzman (2023) examines startups that migrated to Silicon Valley and finds that they experience a significant performance improvement, which is higher than migrations to other regions and higher for startups that exit low-performing entrepreneurial ecosystems. Bryan and Guzman (2023) document significant cross-state startup migration: these firms prefer traditional hubs when they are younger and prefer cities with lower taxes as they mature. Complementing these studies, we focus on a set of high-growth startups, and highlight the role of venture capital in affecting these startups' migration from under-represented areas in VC to traditional capital centers.

Our paper also adds to the literature on the financial constraints of financial intermediaries. We extend the results on financial intermediary constraints in banking (e.g., Paravisini, 2008; Gilje, 2019), showing that despite the differences in the external financing market faced by VCs, these intermediaries face similar issues. Next, Kerr and Nanda (2009) find that bank deregulation and competition matter for high-growth startups, while banks often play a direct role in financing startups (Hellmann, Lindsey, and Puri, 2008). We show that banks' importance for startups also follows their support of startup funders (VCs).

Lastly, we contribute to a literature that uses shocks to LPs or differences in LP commitments to explore the causal effects of VC financing. Nanda and Rhodes-Kropf (2013), Bernstein, Lerner, Sorensen, and Strömberg (2017), González-Uribe (2020), Ewens and Farre-Mensa (2020) and Kortum and Lerner (2000) each use this variation as a mechanism to understand the impact of VC on innovation, startup characteristics, knowledge sharing, and founder bargaining power. These papers implicitly assume that VCs are financially constrained, and therefore, changes in LP supply will first impact VC fundraising and, ultimately, portfolio company outcomes. We take this first assumption head-on, confirming it by directly examining changes in VC fundraising following a negative LP shock and showing that certain VCs are constrained.

1 Data and Institutional Background

1.1 Data

1.1.1 Bank data

We rely on data from banks' Consolidated Reports of Condition and Income (i.e., Call Reports) to identify banks' engagement in VC investments. Banks started to report *venture capital revenue* (VC revenue) in a new category of non-interest income on the Schedule RI-Income statement of Call Reports since 2001. All U.S. national banks, state member banks, and insured state nonmember commercial and savings banks are required by the Federal Financial Institutions Examination Council (FFIEC) to file Call Reports and report VC revenue each quarter. According to the FFIEC, the reported VC revenue primarily includes market value adjustments, interest, dividends, gains, and losses on banks' VC investments, any fee income from VC activities, and the proportionate share of the income or loss from their investments in VC funds. The Internet Appendix section IA.1 discusses the constituent parts of VC revenue.

We augment the Call Reports data with the Consolidated Financial Statements for Holding Companies (i.e., FR Y-9Cs) filed by bank holding companies (BHCs). Unlike bank-level Call Reports, Y-9Cs present information consolidated at the BHC level and are filed by BHCs with assets above a certain threshold. The filing threshold for Y-9Cs has changed over time, from \$150 million to \$500 million in March 2006, from \$500 million to \$1 billion in March 2015, and from \$1 billion to \$3 billion in September 2018. Y-9Cs are also filed quarterly and have similar reportable items as Call Reports that include VC revenue. We link the BHCs to their subsidiary banks using the Summary of Deposits file from the FDIC website.

To compile a sample of banking entities (both banks and BHCs) with VC fund commitments, we include all banks' (both independent and BHCs' subsidiary banks') non-zero VC revenue reported in Call Reports whenever available. To avoid double-counting, we only include a BHC's VC revenue if none of its subsidiary banks reported any VC revenue in a given year. Therefore, we have primarily relied on VC revenue reported in Call Reports. This approach enables us to construct a more granular sample of banking entities investing in VC.[7] BHCs are typically larger and more likely to have locations across multiple states than individual banks. This difference makes it more difficult to assign a specific state location necessary for our analysis. For example, from 2001 to 2013, the average bank has 11 branches, and BHCs have an average of 43 branches belonging to 2.4 banks. Approximately 25% of BHC-held banks with VC revenue also do not share the same headquarters state as their BHC. As the filing threshold for Y-9Cs has changed over time, we only include BHCs with assets above $1 billion throughout our sample period.[8] Lastly, to more precisely capture banks' local impact within a state for our treatment variable, we follow the literature (e.g., DeYoung, Hunter, and Udell, 2004) and exclude large banks with more than half of their branches located outside their headquarters state.[9]

1.1.2 Venture capital data

The commercial data providers VentureSource (formerly owned by Dow Jones, now CB Insights) and Pitchbook provide information on venture capital financings, VC funds, and

[7] As shown in Table IB.5 Panel B, our results are robust if we primarily rely on Y-9Cs to construct the treatment variable.

[8] This threshold invites a comprehensive sample for treatment variable construction. It also provides a consistent estimate of the number of banking entities investing in VC from 2001 to 2018, when another change occurred. Using only Call Reports data, Figure 1 shows data not subject to the threshold changes exhibits similar patterns.

[9] Table IB.5 Panel C shows the results are robust if we include these large banks or exclude large banks with more than half of their deposits generated from branches out of state.

entrepreneurial firms. The sources provide excellent coverage of VC financing rounds for our sample period. One reason for the high coverage is the extensive availability of Form D filings on the SEC website since 2002. Our analysis focused on the years around the 2014 implementation of the Volcker Rule, 2010–2018. The 2010 starting year avoids overlap with the 2008 financial crisis, and the end year ensures we exclude the impacts of the rule's removal in July 2019. The VC fund analysis focuses on funds from the vintage years between 2010 and 2018. Because some less-populated U.S. states, such as Montana and Wyoming, had no VC activity or fundraising over the four-year period before 2014, we exclude these states from analyses. The final sample includes 1,617 VC funds in 35 states. Our VC-backed startup analysis includes the first round of VC funding, either a Seed or Series A round, between 2010 and 2018. We exclude financings greater than $100 million from our startup sample as they are more likely to involve non-VC-backed startups. Our focus is thus on the first early-stage financings of startups between 2010 and 2018. The final startup sample includes 11,048 entrepreneurial firms.

We also use the Preqin database for some of our robustness checks. Specifically, we use the database's VC fund performance and LP commitment information, which Kaplan and Lerner (2016) shows is a transparent and reliable component of Preqin.

1.1.3 Form D data

Form D data provides the key source of information to identify startup migration. Form Ds are exemptions from securities registration filings by firms relying on Regulation D or Section 4(a)(5) of the Securities Act to raise private capital, including venture capital. Our Form D dataset begins with all machine-readable (XML) filings, first available on September 15, 2008 (mandatory after March 16, 2009). These filings (when available) provide information on the startup's directors (see e.g., Ewens and Malenko, 2024), financing amount, and key demographic data. The demographic information includes the firm's legal name, entity type, incorporation state, and incorporation year for firms younger than five years. This incorporation year allows us to identify startups from the set of all Form D filers and also control for the startup founding year.

Most importantly for tracking firm mobility, the Form D filings include the startup's principal business address at the time of filing. Two consecutive filings thus provide data on firm moves. For the pre-2009 period when PDFs were filed, we use the machine-readable information on the SEC website (Edgar) associated with each filing, which conveniently lists the business address. This 2002–2018 sample of Form D filings provides us a comprehensive history of filing-specific business address information for all firms that have filed a Form D.[10] All firms are tracked from their first Form D filing to the earlier of their first move or their last filing. To study the migration of VC-backed startups and fill any gaps in the Form D data for these firms, we also combine the Form D data with VentureSource. VentureSource provides quarterly updates on startup characteristics, including the headquarters state of each startup since 2010.

There are two advantages of using Form Ds to identify startup migration. First, the filings include startups' equity financings and thus capture a representative set of high-growth startups that seek VC financing.[11] Second, the filings can identify non-VC-backed startup movers, expanding our sample beyond those in typical VC databases. For example, Form Ds could identify startup movers that migrated to VC hubs to seek venture capital but failed to secure it.

1.2 Volcker Rule and banks' VC investments

In the aftermath of the 2008 financial crisis, the Dodd–Frank Act was enacted in 2010 to regulate the financial industry and help prevent future financial crises. As part of the

[10] Some studies that also used Form D data (Ewens and Malenko, 2024) show that it exhibits no major bias in the cross-section or time series. However, the coverage of VC-backed startups falls after 2017.

[11] All filings by pooled investment funds and non-incorporated firms are removed from the sample.

Dodd-Frank Act (Section 619), the Volcker Rule statute aims to prevent banks from making certain types of speculative investments that are considered to have contributed to the 2008 financial crisis. The rule specifically prohibits banking entities from investing in or sponsoring a "hedge fund or a private equity fund" – referred to collectively as "covered funds". The rule also classifies individual banks and BHCs (we also refer to them as banks for simplicity) as banking entities.[12]

After Dodd-Frank's passage, U.S. financial services regulators were tasked to write specific rules to implement the Volcker Rule. After a long delay, the regulators eventually issued the final implementation rules on December 10, 2013.[13] The final implementation adopted a surprisingly broad definition of covered funds. Except for a few exclusions and additions determined by the agencies, the definition includes any issuer that relies on Section 3(c)(1) or 3(c)(7) of the Investment Company Act of 1940 for exclusions from being treated as an "investment company". Because all active VC funds use either the 3(c)(1) or 3(c)(7) exemption to avoid having to register and comply with the Investment Company Act's requirements, the adopted definition of "covered funds" includes VC funds in its category thus subjecting them to the restriction of the Volcker Rule.

Prohibiting banks from investing in VC funds in the final ruling created an unexpected policy change for banks and the VC industry. Specifically, Congress did not intend to do so when passing the Volcker Rule statute and clearly expressed its intent. For example, Senator Chris Dodd (D-CT), one of the authors and namesakes of the Dodd-Frank Act states:

> The purpose of the Volcker Rule is to eliminate excessive risk taking activities by banks...properly conducted venture capital investment will not cause the harms at which the Volcker Rule is directed. In the event that properly conducted venture capital investment is excessively restricted by the provisions of section 619, I would expect the appropriate Federal regulators to exempt it using their authority under section 619(J).

[12] See https://www.sec.gov/divisions/marketreg/faq-volcker-rule-section13.htm
[13] See the news release at: https://www.sec.gov/news/press-release/2013-258.

Therefore, Congress clarified that venture capital funds were not the intended target of the fund prohibition. As a result, neither banks nor the VC industry fully expected that the final rules would include VC funds in the fund prohibition category thus barring banks from investing in VC. Many consider such prohibition by the implementation rule as a legal overreach by financial regulators (we also refer to the implementation of the Volcker Rule simply as the Volcker Rule in this study).[14]

Banks had to comply with the Volcker Rule by July 21, 2015.[15] Compliance required banks to divest their existing VC fund investments, though they could apply for extensions for illiquid funds that they contractually committed to before May 1, 2010.[16] Crucially, for our analysis, banks cannot make new investments in VC funds after the final ruling. In the "Order Approving Extension of Conformance Period" released on Dec 10, 2013, the Federal Board states that "banking entities should not expand activities and make investments during the conformance period with an expectation that additional time to conform those activities or investments will be granted."

Before the Volcker Rule, U.S. banks have long been making VC investments under several statutory and regulatory authorities (Hellmann et al., 2008).[17] First, the Small Business Act of 1958 authorizes banks to own and operate "Small Business Investment Corporations" (SBICs) as their wholly owned subsidiaries to make equity investments. Second, Section 4(c)(6) of the Bank Holding Company Act of 1956 allows banks to make VC investments at the bank holding company level, including either direct equity investments in portfolio companies, or indirect investments through limited partnerships.[18] Third, the 1999 Gramm-

[14] See e.g., NVCA letter to federal regulators "Re: Proposed Revisions to Prohibitions and Restrictions on Proprietary Trading and Certain Interests in, and Relationships with, Hedge Funds and Private Equity Funds", October 17, 2018.

[15] This was extended at the time of the final ruling by the Federal Board by one year from July 21, 2014 which was set up by the Volcker Rule statute. See `https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20131210b1.pdf`

[16] See `https://www.federalregister.gov/documents/2011/02/14/2011-3199/conformance-period-for-entities-engaged-in-prohibited-proprietary-trading-or-private-equity-fund-or`

[17] See `https://www.federalreserve.gov/boarddocs/srletters/2000/sr0009a1.pdf`

[18] The reported VC revenue in Call Reports and Y-9Cs could come from both banks' direct investments

Leach-Bliley Act allows banks to engage in various financial activities through financial holding companies, including investing in venture capital.

Why would banks invest in VC funds? First, like any other LP type, investing in VC funds offers banks a way to diversify their revenue and earn higher returns. Second, banks may obtain future banking income from the portfolio companies (i.e., cross-selling) (see e.g., Lerner et al., 2007; Hellmann et al., 2008). Third, banks may also invest in VC funds to access emerging technologies and foster technological collaboration and knowledge transfer, especially in fintech, where they have more asset and business complementarities with the startups (Puri, Qian, and Zheng, 2024).

Using the VC revenue proxy, Figure 1 shows the number of banking entities investing in VC drops sharply by almost 50% after the Volcker Rule's implementation. This number did not drop to zero after the Volcker Rule because banks' existing VC investments may generate revenue, or some banks may still invest in VC under other regulatory authorities, as discussed earlier. These estimations imply that banks' investing in VC funds is the main channel through which banks engage in VC investment activity.[19]

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in VC-backed startups and also indirect investments through VC funds, where only the second type of VC investments are impacted by the Volcker Rule. Unfortunately, the data do not allow us to separate the two types of VC investments. Under the assumption that banks' investment strategies for the two types of investments do not vary systematically across states, the reported VC revenue can reflect the correct sorting of states in terms of their reliance on banks for the supply of capital through VC funds. We also conduct robustness checks for our treatment variable by estimating banks' direct VC investments using forward information after the Volcker Rule's conformance period (2016–2018), eliminating banks with direct investment programs from our sample. We find robust results as reported in Table IB.5 Panel D. We thank an anonymous referee for suggesting these tests.

[19] Banks have different levels of involvement in VC as LPs across the world, for example, they are the most important source of capital for VC funds in Germany, investing in almost 60% of them (Mayer, Schoors, and Yafeh, 2005).

2 Estimation Strategies

2.1 The importance of banks for VCs

Banks were an important source of capital for the VC industry before the Volcker Rule.[20] Based on VC revenue reported from both Call Reports and Y-9Cs, Panel A of Table IB.2 shows that banks had an average investment position of about $27.9 billion in the VC industry (the first column). This commitment constitutes 6 to 10% of venture capital raised in the U.S. (the third and fourth column) before the Volcker Rule. Other sources provide similar estimates. For the 1991–1998 period, Lerner et al. (2007) find that banking and finance companies represent the sixth largest investor class in PE and VC funds, accounting for about 4% of all LP investors in VC funds and 8% of all LP investors in both PE and VC funds.[21] Relatedly, a Preqin Special Report released before the Volcker Rule documents that banks account for about 8% of the total capital invested in private equity, making them the fifth most significant investor type.[22] These estimates show banks provided meaningful capital to the VC industry before the Volcker Rule.

2.2 Construction of the treatment variable

We aim to create a variable that approximates the relative exposure of a VC firm to the Volcker Rule change. The idea is that a VC in state i is more exposed to the Volcker Rule if that state has relatively higher participation of within-state banks as VC fund LPs. Thus, we calculate cross-state differences in local banks' investing in VCs before the Volcker Rule. Because VC fund investments are illiquid, observing banks' VC revenue takes time after they

[20] Banks' involvement in VC is not random, Table IB.1 shows that the average bank engaging in VC investments is 15 times larger than an average bank that is not involved in VC investments based on Call Reports data.

[21] These estimates are likely underestimates because the data came before the Gramm-Leach-Bliley Act, which significantly relaxed constraints on banks' ability to invest in VC.

[22] See "Preqin Special Report: Banks as Investors in Private Equity", 2012.

make VC fund commitment. To better capture the capital flow from banks to VC funds, we first aggregate the number of bank-years with VC revenue in a state over the period 2001–2013. To account for differences in the size of local VC markets, we scale this number by the number of VC funds raised over the same period in the state. This ratio of aggregate bank-years with VC revenue to the VC funds raised is our state-level measure of VC funds' pre-Volcker Rule bank exposure – "Bank Expo".[23] Although the Volcker Rule took time to implement, there is no evidence that banks or the VC industry anticipated the change nor adjusted their allocations in advance (see Figure 1). Therefore, we treat the "Bank Expo" variable as plausibly exogenous and use it as our treatment variable. We also construct a binary treatment variable for use in additional tests: "High Exposure" or "High Expo," an indicator variable equal to one if a state's bank exposure is above the sample median among all states in our sample. The first two columns of Table 1 present these measures by state.

The bank exposure variable captures the intended variation. First, using the same approach as in Subsection 2.1, we estimate banks' capital share in total venture capital raised for the group of states with high bank exposure and those with low bank exposure. Banks' capital share is much higher in the high bank exposure group than in the low bank exposure group, regardless of how we scale bank capital to derive banks' capital share (Table IB.2, Panel A). Second, we correlate the bank exposure variable with numerous state-level attributes, including GDP growth and GDP per capita, and find no correlation (Figure IB.4). The result suggests that states with different bank exposure do not differ significantly in other economic conditions that are not directly related to VCs.[24]

[23] We would ideally observe exact LP commitments. In Subsection IA.2, we conduct a theoretical exercise by connecting our treatment variable with such an ideal treatment variable based on bank commitments. We find that the two variables are proportional under reasonable assumptions that we confirm are consistent with market practice.

[24] In unreported results, we correlate the bank exposure variable with more state-level attributes that are commonly used in the literature (e.g., Gompers and Lerner, 1998). These include state capital gain tax rate, R&D expenditure per capita, and education (percent of adults completing some college or associate's degree), and we find weak or no correlation.

2.3 The high bank exposure of VCs based in non-VC hubs

We next explore the geographic variation in VCs' bank exposure. First, VCs' bank exposure differs significantly across regions. Panel A of Figure 2 shows that the Midwest and South have higher bank exposure than other regions before the Volcker Rule, although these regions have a small VC industry presence (Figure IB.2, Panel A).[25] Similarly, non-coastal states typically have higher bank exposure than the coastal states (Figure 2, Panel B). Next, states outside traditional VC hubs have much higher bank exposure, while VC hubs (CA, MA, and NY) all rely little on banks for capital and have very low bank exposure (Table 1).

We formally estimate the relation between VCs' bank exposure and the local VC market's size. At the state level, a VC "imbalance" measure is the ratio of VC activity per capita to the VC activity per capita in the U.S. each year averaged over 2001–2013 (Klein, 2018). Imbalance is measured for three VC activities: the number of VC funds, the amount of venture capital raised, and the number of startups funded by VCs (columns 3-5 of Table 1).[26] Regardless of the VC activity measure, there is a robust negative correlation of about −0.3 between the imbalance measures and the bank exposure variable (also see a plot in Figure 3). These results confirm that states with relatively small VC markets had higher bank exposure pre-Volcker Rule. Reassuringly, a regional-level VC imbalance measure shows that regions with high bank exposure (i.e., Midwest and South) also have historically low VC development (Table 1). The negative correlation between the development of a local VC market and the bank exposure variable is a key feature of our empirical setting. It underpins our analysis of the relationship between the supply of venture capital and startup clustering.

[25] The numerator of our treatment variable (i.e., the number of bank-years with VC revenue over the period of 2001–2013) exhibits a significant regional variation that is consistent with our treatment variable (see Figure IB.1).

[26] We also compute state-level imbalance measures based on the number of LPs (for all LPs and also the largest LP type – pension funds), patents, and high-skill employment (see columns 6-9 of Table 1).

2.4 Estimation strategy

Given the regional differences in banks' commitments to VC funds and LPs' tendency to invest locally, we expect that the Volcker Rule differentially impacted VCs across U.S. states. Hochberg and Rauh (2013) show that institutional LP investors, such as public pension funds, exhibit substantial home-state bias in private equity investments. They also show home-state bias is greater in VC funds than buyout funds. We confirm their findings for banks as LPs in Table 5 Panel A (see more discussion below).[27] It has also been well documented that VC investors invest locally (see e.g., Chen et al., 2010). Therefore, LP and VC bias toward local investing interacts with regional differences in bank investment in VC to generate regional differences in local VCs' and entrepreneurial firms' exposure to the Volcker Rule.

We exploit this cross-sectional heterogeneity in bank exposure across states to identify the impact of the Volcker Rule on VC fundraising, startup financing, and startup migration. Our estimation strategy is a difference-in-differences (diff-in-diff) regression. The analysis compares the outcomes of interest between 2010–2013 with that between 2014–2018.[28] Estimations have different units of analysis, including state-year, VC fund, VC-backed startup, and startup-year level. In each, our regression framework takes similar forms. Using the analysis of startup financing as an example, we estimate the following:

$$Y_{it} = \beta_1 Bank\, Expo_i * Post_t + \beta_2 X_i + \gamma_t + \epsilon_{it} \tag{1}$$

[27] Our analysis requires banks to invest a larger share of their VC investments into local VCs before the Volcker Rule. However, this need not be driven by home bias. For example, a higher share of bank investments in local VCs in the Midwest could be driven by a selection of bank LPs to under-subscribed local VCs. Such a mechanism does not impact the ability of our treatment variable to capture local VCs' bank exposure to the loss of bank LPs following the Volcker Rule.

[28] Though the Volcker Rule became effective on April 1, 2014, the final rules to implement it were released on December 10, 2013, which made clear the prohibition of banks from investing in VC funds and also set up a specific conformance period with the Volcker Rule. Therefore, we choose 2014 as the beginning of the "Volcker period."

where X_i are entrepreneurial firm characteristics at the time of the investment, including state fixed effects, founding year fixed effects, and industry fixed effects; γ_t are year fixed effects corresponding to the year of investment. The main coefficient of interest (β_1) is the interaction between "Bank Expo" and "Post" (equal to one for 2014 to 2018).

The "Bank Expo" treatment variable is continuous and thus captures richer cross-state variation than a binary alternative. For example, Arkansas has bank exposure more than twenty times as high as Ohio, but both would be assigned the same high bank exposure group (see Table 1). On the other hand, Ohio has very similar bank exposure to Nebraska, but they would be assigned different bank exposure groups. Therefore, throughout the paper, we use "Bank Expo" as the main treatment variable in our diff-in-diff analyses.

3 Impact on VC Fundraising Activity

We first document that the Volcker Rule negatively impacted VC fundraising activity. Thus, the loss of banks as LPs was not fully filled by other types of LPs, leaving local VCs outside the venture capital hubs financially constrained.

3.1 VC fundraising activity

First, we study the impact of the Volcker Rule on VC fundraising activity by calculating the number of newly raised VC funds in the high-exposure and low-exposure states from 2010 to 2018. Figure 4 shows that while fundraising evolved similarly pre-Volcker, a marked difference in the number of newly raised VC funds emerged across the two groups of states in the post-Volcker period. Thus, a state's exposure to banks as VC LPs pre-2014 predicts shifts in VC fundraising activity.[29]

[29] Figure IB.5 plots the number of newly raised VC funds over the long sample period of 2001–2018, and shows a similar pattern.

We next explore this relationship in a diff-in-diff analysis using state-year observations of the count of VC funds and dollars raised over the 2010–2018 period (see summary statistics in Table 2 Panel A). Panel A of Table 3 reports the estimation results. Columns 1-4 have the natural log of one plus the number of VC funds raised as the dependent variable, while columns 5-8 have the natural log of one plus the aggregate amount of venture capital raised as the dependent variable. For each dependent variable, the first column includes state and year fixed effects, the second column adds time-varying, state-year level controls, the third column excludes the state of California from our sample, and the fourth column focuses on a narrower sample period of 2011–2017. For state-year level controls, we follow Gompers and Lerner (1998) and control for state GDP growth and log of state GDP per capita throughout the paper. We also control for state house price growth and STEM employment growth to eliminate potential confounding effects related to housing and labor market conditions.

Panel A of Table 3 shows a significant decrease in VC funds and total capital raised in states more exposed to the Volcker Rule. The estimates in columns 1 and 5 suggest a one-standard-deviation increase in bank exposure (e.g., moving from California to Wisconsin) leads to 11% fewer VC funds and 9% less total venture capital raised.[30] This drop represents about 0.6 VC funds and $57 million in a state per year. The estimates in Panel A of Table 3 also show that our baseline results are robust to the exclusion of CA-based VC funds, which account for about 45% of all U.S. VC funds (columns 3 and 7). Lastly, the results are insensitive to shrinking the sample period to 2011–2017 (columns 4 and 8). Overall, the Volcker Rule significantly impacted the supply of venture capital in states with higher bank exposure.[31]

[30] In our setting, the standard deviation of our treatment variable "Bank Expo" is different across the regression samples due to different units of observation (Table 2), and we use the regression-specific variation whenever reporting magnitudes.

[31] Another robustness test re-estimates the baseline regression by excluding one state at a time from our main regression sample. The coefficient estimates in Figure IB.6 suggest a single state does not drive the main results.

We next explore how much of these results can be explained by the rule change's impact on existing VC investors in the state. Panel B of Table 3 reports the VC fund level regression results estimated from Eq. (1) with the natural log of fund size as the dependent variable (see summary statistics in Table 2 Panel B). Columns 1-3 include all VC funds closed over the 2010–2018 sample period. We include VC fund vintage year and VC firm fixed effects to control for VC fundraising cyclicality and the cross-sectional heterogeneity in VC firms' ability to raise funds.[32] VC fund size also increases as a function of the fund sequence within a VC firm, so column 2 includes VC fund sequence fixed effects. Column 3 introduces time-varying, state-year level controls. The results in the first three columns of Panel B show that the average VC fund size falls after the Volcker Rule in states more exposed to the rule change. The economic magnitude is large. For a one-standard-deviation increase in bank exposure in a state, e.g., moving from New York to Missouri (see Table 1), the average VC fund successfully closed is about 22% smaller (column 1). These estimates are robust to excluding California-based VC funds (column 4), narrowing the analysis to 2011–2017 (column 5), and only considering VC firms that raised funds both before and after the rule change (column 6).

Lastly, we estimate a within-VC firm effect of the Volcker Rule by examining VC firms' probabilities of raising a follow-on fund across states in the post-Volcker period. Table 3 Panel C reports the estimation results, where the dependent variables are indicators of whether a VC firm has raised a new fund to a certain year over the post-Volcker period. Over different event windows, the results in Panel C consistently show that higher bank exposure leads to a lower probability of raising a follow-on fund. This within-VC firm evidence further suggests that VC firms raise not only smaller but also fewer funds.

Overall, the results in Table 3 document declines in VC fundraising activity for states

[32] The VC industry is highly cyclical (Gompers, Kovner, Lerner, and Scharfstein, 2008), while VC firms' ability to raise big funds varies considerably (Pitchbook-NVCA 2020 Venture Monitor).

more exposed to the Volcker Rule. The number of VC funds raised, and the probability of raising a follow-on fund dropped, while funds that did successfully close were smaller.

3.2 The parallel trend assumption

As with any difference-in-differences estimation strategy, our key identifying assumption is parallel trends – that is, the states with low bank exposure provide an appropriate counterfactual for what would have happened to the states with high bank exposure had they not been negatively impacted by the Volcker Rule. While the parallel trends assumption cannot be tested, we aim to validate it in several ways. First, Figure 4 shows that the number of VC funds in states with high bank exposure evolves similarly to that in states with low bank exposure over the pre-Volcker Rule period (2010–2013). Only after the implementation of the Volcker Rule does the trend diverge. This provides support for the parallel trends assumption.

We also inspect state-level pre-treatment trends of the outcome variables by estimating a dynamic model of Eq. (1). We replace the single interaction variable in Eq. (1) with a set of interaction variables between the bank exposure variable and year dummies over 2010–2018 (2013 is omitted). The first two columns of Table 4 show that the pre-treatment coefficients are insignificant for all of 2010–2012 when we use the same dependent variables as those in Table 3 Panel A. In columns 3-4, we partition VC funds into groups of small versus large funds using the sample median of fund size in each state and consider the number of VC funds in each group as the outcome variable. Again, the coefficients are insignificant for both columns for all of 2010–2012. The collection of results in Table 4 corroborates the validity of our diff-in-diff specification.

To further validate our diff-in-diff model, we also conduct various placebo tests and discuss the potential impact of the 2008 financial crisis on our results in Section 5 (see Tables IB.4 and IB.5).

3.3 LP home bias and availability of alternative LPs

The Volcker Rule negatively impacted VC fundraising activity, suggesting that no other institutional investors stepped in to substitute for banks' capital. This section explores this issue directly.

A combination of geographic frictions (e.g., LP home bias) and unequal distribution of LPs across the U.S. (columns 6-7 of Table 1) could prevent non-local LPs from filling the gap left by bank LPs. This, in turn, could drive the decline in post-Volcker VC fundraising activity in states outside the major VC hubs. We first study LP's home bias for VC funds using Preqin's capital commitment data. Following Hochberg and Rauh (2013)'s definition, an LP type's home bias is a measure of in-state overweighting, which is the share of in-state investments against two benchmarks. The first benchmark is the share of all investments in the LP's state in the preceding five years (BM1), and the second is the share of all out-of-state investments in the LP's state in the preceding five years (BM2).

Columns 1-3 of Table 5 Panel A show that bank LPs exhibit significant home bias that exceeds other major LP types, such as public pension funds. For example, bank LPs, on average, make 23.2% of their investments into VCs in their home state, which is 11.5% higher than the average share of all VC investments made in that state and 11.9% higher than the average share of all out-of-state investments made in the state. The last three columns report estimates at the LP-year level and deliver similar results. Table 5 Panel A thus confirms that all active LP types in VC investing – including banks – exhibit significant home bias. This bias is a clear mechanism limiting the flow of out-of-state LP capital to the regions impacted by the loss of bank LPs post-Volcker Rule.

We next study whether the availability of alternative local LPs attenuates this home bias. If a region has a relatively smaller stock of alternative local LPs who can substitute for lost bank LPs, these regions may experience larger negative impacts post-rule passage. As pension funds and endowments collectively contribute to about 70% of PE allocations, they provide a measure of alternative LP availability. We construct a proxy of alternative state-level LP assets as the total assets under management (AUM) of the pension fund and endowment LPs in a state scaled by state GDP. Equipped with the proxy, we re-examine our findings in Table 3. A split-sample analysis compares states with large LP assets versus small LP assets, while a triple-difference analysis includes LP assets as an additional interaction variable. For both the number of VC funds and the amount of venture capital raised as the dependent variables, Panel B of Table 5 demonstrates that the Volcker Rule's negative impact on VC fundraising activity is concentrated in states with few alternative LP assets (i.e., states with LP assets below the sample median).[33]

These two patterns – LP home bias and the relative impact based on alternative LPs – can help explain why the passage of the Volcker Rule harmed VC fundraising. Likely not by design, this impact was concentrated outside traditional VC hubs and could thus impact high-growth startups in those regions. We study that issue next.

4 Impact on Startups

To understand the impact of the Volcker Rule on local high-growth startups across regions, we study changes in the financing of VC-backed startups, and startups' migration to VC hubs.

4.1 Startup financing

We first study the Volcker Rule's impact on the capital a startup raises in its first round of VC financing. We estimate Eq. (1) with the natural log of the investment size in startups' first round of VC financing as the dependent variable, and report the regression results in

[33] We also use the interaction between state pension assets and the fraction of state officials in the funds' boards of trustees as a sorting variable (Ewens and Farre-Mensa, 2020), and find a significantly differential treatment effect for the number of VC funds raised in a state, see Table IB.6 Panel B.

Panel A of Table 6 (see summary statistics in Table 2 Panel C).[34] The sample in columns 1-3 includes all VC-backed startups that have raised their first VC funding between 2010 and 2018. Column 1 includes startup headquarters (HQ) state and financing year fixed effects. Column 2 introduces a specific round (either Seed or Series A), founding year, and industry fixed effects, while column 3 adds time-varying, state-year level controls. The results in the first three columns of Panel A show a significant decrease in the amount of capital invested by VCs in startups' first financings after the Volcker Rule. The estimates imply that a one-standard-deviation increase in bank exposure leads to a smaller average amount of capital invested of about 7% (column 1), or a 0.34 million dollar fall in the average amount of capital invested in the first round of funding. The results are robust to excluding startups located in CA (column 4) and narrowing the analysis to 2011–2017 (column 5). Panel A of Table 6 shows that startups inherit their VC investors' financial constraints and raise less money after the Volcker Rule.[35]

A drop in the supply of VC could impact startup valuations. Changes here help reveal the relative importance of capital supply, capital demand, and the bargaining power of VCs and entrepreneurs (Gompers and Lerner, 2000). Using the natural log of startup pre-money valuation at their first VC funding as the dependent variable,[36] we estimate a similar regression as column 3 of Table 6 Panel A and report the estimation results in column 1 of Table 6 Panel B. There is a significant decrease in the pricing of startups post-Volcker Rule: a one-standard-deviation increase in bank exposure leads to a 9% lower valuation (approximately $1.3 million) in their first round of funding.[37] Consistent with our results in

[34] Figure IB.7 plots the coefficients estimated from a dynamic specification of Eq. (1) and demonstrates that there is no observable pre-trend.

[35] In Panel A of Table IB.7, we consistently find that the total initial capital invested in startups was lower in states more exposed to the Volcker Rule.

[36] The pre-money valuation is the perceived NPV of the company before the capital injection, and hence more accurately measures financing conditions faced by startups than post-money valuation.

[37] The regression sample consists of 5,903 VC-backed startups with reported valuations from their first VC funding. Valuation revelation is non-random (Ewens and Farre-Mensa, 2020), so the results use a positively selected set of startups. For these tests, we believe this attenuates our ability to find impacts because

Table 6 Panel A, startup valuation declines show that startups inherit their VC investors' financial constraints and face worse financing conditions after the Volcker Rule. Column 2 shows that the fraction of equity shares sold to VC does not change. Paired with the result in column 1, this suggests the decline in VC availability resulted in value loss to both founders and VC investors.

Is the decline in the capital raised by startups driven by fewer VC investors investing or less capital invested by participating investors? To answer this question, we estimate Eq. (1) using the natural log of syndication size – the number of investors in the financing – in startups' initial VC financing round. Syndication is common among VC investments, e.g., the first round of VC financing has an average of nearly three VC investors (Table 2). The third column of Table 6 Panel B shows that the number of VC investors that co-invest in a startup's first financing falls in states with higher bank exposure post-rule change.[38] This decline is consistent with previous results showing fewer VC funds after the rule change.

Lastly, we investigate the impact of the Volcker Rule using VC-backed startups' pre-VC financing from angels or accelerators (Kerr, Lerner, and Schoar, 2014; González-Uribe and Leatherbee, 2018). The final column of Table 6 Panel B shows that VCs are more likely to invest in startups that have received pre-VC funding after the Volcker Rule in the states more exposed to the rule change. This increase in non-VC financing is consistent with startups responding to the expected VC supply shock. The collection of changes around VC financing shows that startups outside the traditional VC hubs absorb some of their VC investors' financing constraints.

relatively higher valuations are most likely to be reported.

[38] In Table IB.8, we also find that conditional on financing, the average amount of capital invested per investor also falls after the Volcker Rule.

4.2 Startup migration

The findings that startups struggle to raise capital when their local investors face similar struggles suggest that the former may seek alternatives. The multiple rounds of financing over 4 to 8 years needed to build a successful high-growth startup lead to the strategy we study next: startups may move to where the capital is available. This section asks whether the decreased supply of local venture capital impacts startups' migration to places with more abundant capital supply, i.e., VC hubs (CA, MA, and NY).

Table 7 Panel A presents summary statistics for startup movers – both VC-backed and non-VC-backed – by destination state.[39] Movers are identified with Form D filings (see Section 1.1.3). California attracts the largest number of startup movers than any other U.S. state, and the top three VC hub states (CA, MA, and NY) – defined based on VC investment activity – are also the top three destination states for migrated startups. Among startup movers, about 80% are incorporated in Delaware. Restricting startups to those that moved to VC hubs, almost 60% operate in high-tech sectors such as technology or biotech, and 65% eventually raise VC funding. The movement appears connected to industry. Startups in the technology sector account for a higher fraction of startups moving to California, while those in biotech account for a higher fraction of startups moving to Massachusetts. These estimates on startups migrating to VC hubs suggest that they represent the typical type of startups financed by VCs, and VC funding is likely one important underlying channel driving their migration.

Panel B of Table 7 presents summary statistics for VC-backed startup movers identified using Form Ds and VentureSource. Startups that moved to VC hubs are 4.5 years old on average at the time of moving. Before they move to VC hubs, 10% have not yet raised any funding, 5% raised some non-VC funding from sources such as crowdfunding, angel or accelerator, 42% raised a first round of VC funding, and another 17% raised a second round of

[39] Table IB.9 provides summary statistics for startup movers by treatment.

VC funding. In total, nearly 75% of startups that moved to VC hubs raised at most a second round of VC financing before moving. Thus, conditional on VC funding, the overwhelming majority of startups that moved to VC hubs are early-stage startups who appear to move to VC hubs for capital access. VC funding is thus likely an important channel motivating startups to move to VC hubs when they face local VC funding shortages.

We next investigate startups' migration to VC hubs using a startup-year diff-in-diff estimation. The sample of startups includes movers and non-movers, with and without VC financing.[40] The estimation results are reported in Table 8 Panel A, where the dependent variable is a dummy variable indicating whether a startup has moved its headquarters to CA.[41] As VCs typically invest in Delaware-incorporated startups, all regressions include incorporation state FEs. Along with the standard fixed effects for time, cohort, and industry, regressions include time-varying, state-year controls measured at the startup's origin headquarters state in column 2. We replace state-year controls with origin headquarters state fixed effects in column 3.[42] The first three columns of Panel A show that startups headquartered in states that are more exposed to the Volcker Rule are more likely to move to CA after the rule change. The economic magnitude is significant. For a one-standard-deviation increase in bank exposure in a state, a startup's likelihood to move to CA increases by 30% relative to the sample mean (column 1). These estimates are robust to excluding startups that are already headquartered in California (column 4), narrowing the analysis to 2011–2017 (column 5), and conditioning on startups that ever moved to a different state during our sample period (column 6).[43]

While VC funds based in California accounted for 62% of VC dollars raised in 2018,

[40] We conduct a similar exercise using early-stage VC-backed startups retrieved from VentureSource and find robust estimates; see Table IB.10.

[41] All regression coefficients have been multiplied by 100 in the migration analyses.

[42] The results are robust after applying generalized propensity score (GPS) weighting, see Table IB.11.

[43] Among startups moving to CA, about 70% of them moved to Silicon Valley, and we find robust results if focusing on startups' migration to Silicon Valley in Table IB.12.

Massachusetts and New York accounted for 13% and 17%, respectively. Panel B of Table 8 investigates migration to these states and CA ("VC hubs"). The estimates show a 24% increase (relative to the sample mean) in the likelihood of moving to VC hubs for a one-standard-deviation increase in bank exposure to the Volcker Rule (column 1).[44]

Startups could move for non-capital sourcing reasons (see e.g., Bryan and Guzman, 2023). While they are more likely to move to areas with VC after a negative shock to local VCs (Table 8), exposure to the treatment should have no predictive power for moving to other areas with low VC. To address this, we conduct a placebo test using startups' migration to all states except the top three VC hub states (i.e., non-VC hubs). Consistent with our hypothesis, we find that startups in states with different bank exposure have a similar likelihood of moving to non-VC hubs after the Volcker Rule (see Table 8 Panel C). We also test the coefficient differences across model specifications between those in Panels A-B and Panel C of Table 8, and find a significantly differential treatment effect on startups' migration to CA or VC hubs relative to their migration to non-VC hubs (see Table IB.13 Panel B).

Overall, the decrease in the supply of venture capital in regions outside the traditional VC hubs increased startups' migration to VC hubs (but not to non-VC hubs). These moves exacerbate startup clustering while highlighting the role of local risk capital in startup agglomeration.

4.3 The role of industry and geographic distance

We next explore how industry alignment or geographic distance might alter startup migration patterns. Agglomeration often happens by industry, where the benefits of intellectual spillovers or labor market pooling are maximized (e.g., Carlino and Kerr, 2015). Thus, agglomeration forces may lead startups to move to a VC hub with their industry. Similarly,

[44] A dynamic specification for startups' migration to CA and VC hubs finds all statistically insignificant regression coefficients pre-2014 and thus no evidence of observable pre-trends in startup migration (Table IB.13, Panel A).

geographic distance may also matter as a smaller distance between the origin and the destination may be associated with lower information asymmetry (Chen et al., 2010) and reduce the cost of moving (Dahl and Sorenson, 2012).

After identifying the dominant sector for VCs in each VC hub state, we ask whether a startup's industry predicts their mobility choice. The dominant sector in a VC hub state is the sector commanding the highest VC investment share in the U.S. As expected, the dominant sector in CA and NY is technology, with MA dominant in biotech. Let the dummy variable "Dom. Sector" indicate whether a startup is operating in the dominant sector of the VC hub. We include this variable as an additional interaction variable in the regression. The estimation results for CA, reported in columns 1-2 of Table 9, show that startups operating in the technology sector do not have a higher likelihood to move to CA relative to those in other sectors in response to a negative VC shock. Similarly, the results in columns 3-4 of Table 9 show that startups operating in the biotech sector do not have a higher likelihood of moving to MA. The last two columns deliver a similar message for NY. Taken together, startups do not appear to consider industry alignment in their migration decisions following local VC shortages. This is consistent with the idea that financially constrained startups may consider funding – rather than industry agglomeration benefits – the most important factor in the migration decision.

We next examine the role of geographic distance in affecting startups' migration to VC hubs. We compute the natural log of the minimal distance between a startup's zip code and the city with the most VC investments in each possible destination state in Table 10 Panel A. Column 1 shows after including this measure as an interaction with the bank exposure treatment, geographic distance has little explanatory power for a startup's migration to CA post-Volcker Rule. Thus, CA's role as the dominant location for VC in the U.S. manifests as an insensitivity to distance. The remaining columns of Panel A show that geographic distance negatively impacts startups' migration to VC hubs on average, but the effects are mainly driven by startups' migration to MA. Overall, there is little evidence that geographic distance significantly influences startups' migration decisions after negative capital supply shocks. Panel B considers a smaller set of startups initially headquartered in the middle of the U.S. (i.e., non-coastal states).[45] These startups were more exposed to the Volcker Rule. While these startups are more likely to move to CA or VC hubs in general (columns 1-2), they are not more likely to move to the closest VC hub or coastal state (columns 3-4). The estimations in Panel B further show that geographic distance does not play a major role in altering startups' migration choices when they face a negative local VC shock and try to meet potentially urgent funding needs.

4.4 VC funding constraints and startup migration

Thus far, neither distance nor industry provides much predictive power for startups' propensity to move to VC hubs. Using three proxies, our final tests explore the role of VC funding constraints (above and beyond those from the Volcker Rule).

Capital requirements differ significantly across industries. For example, the capital raised by information technology (IT) startups in their first VC financings is only about 65% of that raised by biotech startups. We use this industry variation in capital needs in Panel A of Table 11. Here, biotech startups are more likely to move to VC hubs on average than startups in other sectors following the implementation of the Volcker Rule (see column 2). Though not statistically significant, the coefficient estimate exhibits a positive sign for each of the three VC hub states.

Next, startups tend to raise larger amounts of capital as they age. This increased capital demand by firm age provides our second source of variation to explore the impact of capital supply shocks on migration. We expect older firms to be more sensitive to the reduction

[45] We define U.S. coastal states as the 9 contiguous states along the Pacific Coast and Atlantic Coast: CA, OR, WA, MA, NY, CT, VA, MD, NH.

in local venture capital supply and, thus, more likely to migrate to VC hubs. Indeed, the triple-difference analysis using the log of startup age as an additional interaction variable in Panel B of Table 11 shows that older startups are more likely to move to CA or VC hubs after the Volcker Rule.

Our final financial constraints proxy considers the role of VC industry concentration. There is significant heterogeneity in VC investing across industries, and it is concentrated in a selected set of industries (Lerner and Nanda, 2020). Startups operating in industries with higher intensity of VC investments are more reliant on VC funding and, thus, are likely impacted more by the decline in capital (i.e., they have fewer financing alternatives). The variable "High VC-funded" indicates whether a startup is operating in an industry with the fraction of startups funded by VCs in this industry above the sample median. The triple interaction results in Panel C of Table 11 show that startups operating in high VC-funded industries are more likely to move to CA or VC hubs after the Volcker Rule.

In sum, the estimates based on the three proxies for startup-level financing constraints suggest that startups' migration depends on their capital demands and local constraints. When startups face local VC shortages, they are more likely to move to where the capital is located, i.e., VC hubs. These additional results indicate that the availability of VC funding – though not necessarily the industry or relative distance – is an important driver of startup migration and, thus, startup agglomeration.[46]

4.5 The syndication of local and remote investors

Having documented the negative impact of VC shortages on local startups regarding VC financing and the startup's propensity to move to the available capital, we next explore why non-local VCs did not fill the gap.

[46] In additional analysis related to startup agglomeration, we also find that local innovation is negatively impacted by the Volcker Rule (see Table IB.14), and there is an inverted-U relationship between VC funding and startup formation rate at the state level (see Table IB.15).

VC investing involves significant information asymmetry and thus requires intensive pre-investment screening and frequent post-investment monitoring (e.g., Lerner, 1995). These features also explain why VC investing exhibits strong local bias (e.g., Chen et al., 2010) and why VCs that invest at a distance are sensitive to the cost of these interactions (Bernstein et al., 2016). We thus predict that when VCs invest remotely, they must mitigate the geographic disadvantages. One partial solution is to co-invest (i.e., syndicate) with VCs local to the startup.

To test this, we study whether the distance between a non-local investor and a startup correlates with the presence of a local VC. Table 12 Panel A presents the results. The farther a startup is from non-local VCs in its syndicate, the more likely a local VC is involved (column 1). Here, a 10% increase in the distance between out-of-state VCs and startups is associated with a 0.5% increase (relative to the mean of 0.65) in the likelihood of syndicating with local VCs. The remaining columns of Panel A show that these results are robust to additional controls and sub-samples. These estimates help explain why the loss of local capital cannot be easily substituted with distant VCs.

We take this correlation to our primary empirical strategy by estimating diff-in-diff regressions related to the presence of in-state versus out-of-state VCs. Table 12 Panel B reports the regression results. The dependent variable is a dummy variable indicating whether a startup has raised first-time capital from a same-state investor (columns 1-2), and from an out-of-state investor (columns 3-4). The results in the first two columns show that the Volcker Rule negatively impacted local VC supply for affected startups. In contrast, columns 3-4 suggest that the Volcker Rule had no significant impact on the availability of out-of-state VCs. Thus, VCs outside the traditional VC hubs did not step in to fill the gaps left by the local VCs in the affected regions. The last two columns also present the coefficient differences for having in-state versus out-of-state VC and show a differential treatment effect.

Taken together, the results in this section confirm our earlier findings that the Volcker

Rule negatively impacted the supply of local venture capital, while shedding light on how two well-known VC investing patterns – investor syndication and close proximity of VC investments – could interact and impact the allocation of capital across regions.

5 Robustness checks

Our identification in this paper assumes no simultaneous, confounding change in 2014 that also impacted VC activity across states. One such potential change is the 2008 financial crisis, which could have a lasting and differential impact on VC activity across regions. Our baseline analysis considers a sample starting in 2010 to avoid any overlap with the financial crisis. In support of this choice, Ewens, Nanda, and Rhodes-Kropf (2018) shows that the impact of the financial crisis on the VC industry was mostly confined to 2009.[47] Additionally, we can narrow the sample period to between 2011 and 2017 with similar results in all diff-in-diff analyses. Panel B of Table IB.7 presents the extreme version of this test, narrowing the sample period to 2013–2014. The number of VC funds, especially small VC funds, falls post-Volcker Rule in states more impacted by the rule change.

The 2008 financial crisis had a broad impact on various sectors of the economy, including banking, finance, and real estate. Thus, it is possible this negative shock had spillover effects on the VC market in ways unrelated to a change in bank regulation. For this to explain our results, the spillover effects must have impacted the same set of states as we have identified using our bank exposure variable. As we constructed this variable using banks' participation in VC, some of the more obvious confounding channels could be related to the banking sector in a given state. We examine changes in banking sector conditions around the Volcker Rule to investigate this alternative hypothesis.

Specifically, we run placebo tests with various outcome variables measuring bank lending,

[47] Ewens et al. (2018) document that while there was a 25% decline in the number of venture deals from 2008 to 2009, deal volume actually increased by 15% from 2009 to 2010.

bank health, and local banking market structures. For bank lending, we leverage Call Report loan data to measure loans made to various sectors of the economy, especially those at the epicenter of the 2008 financial crisis. These sectors include real estate, commercial banks (cross-bank lending), individuals (credit card loans), commercial and industrial loans (C&I loans), and total loans and leases. We measure bank health with capitalization level, asset quality, liquidity, and profitability (see e.g., Duchin and Sosyura, 2014). Lastly, we measure local banking market structure using bank concentration measures: the Herfindahl-Hirschman Index (HHI) computed based on bank branches and deposits, and the share of the largest three banks by the number of branches and amount of deposits in a state (see e.g., Canales and Nanda, 2012). The estimations, reported in Table IB.4 Panels A-C, consistently show that states with different bank exposure do not exhibit differences in banking sector conditions. This result suggests that local banking market conditions are unlikely to be a confounding channel.

To further validate our diff-in-diff model, we conduct placebo tests with economic variables that are not directly related to VC activity and presumably also less impacted by the Volcker Rule. Specifically, we adopt six outcome variables in three categories: IPOs of VC-backed companies, state GDP, and the relative size of the LP market in a state. The main interaction coefficient estimates in Table IB.4 Panel D are all insignificant. Therefore, our baseline results are unlikely to be driven by the heterogeneity of economic circumstances between the treated and control states.

Lastly, our results are robust to alternative specifications such as Poisson regression (Cohn, Liu, and Wardlaw, 2022) or an inverse hyperbolic sine (IHS) transformation of our count dependent variable (see Table IB.5 Panel A). Alternative constructions of the treatment variable such as transforming our treatment variable with the natural log of one plus function, using the number of unique banks with VC revenue as the numerator, scaling the numerator of our treatment variable by state GDP, population, and the number of patents and STEM employment have no impact on our results (see Table IB.5).

6 Conclusion

We investigate venture capital firm financial constraints and their impact on local startups' financing and migration. Following the implementation of the Volcker Rule, banks were prohibited from investing in VC funds as limited partners. Their participation was predominantly in VC funds outside the VC hubs of California, Massachusetts, and New York. Thus, this rule change disproportionately impacted regions where policymakers had worked hard to fill funding gaps for VCs and startups. The rule change led to fewer and smaller VC funds, while startups in the impacted states raised less money at worse valuations. The results show that VCs in the treated states are financially constrained, and startups can not completely cushion themselves from this loss. Finally, the documented migration patterns provide evidence that the VC funding channel drives high-growth startup agglomeration.

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7 Figures and Tables

Figure 1: Number of banking entities with VC revenue by reporting year

This figure plots the number of banks and bank holding companies (BHCs) with VC revenue by reporting year from 2001 to 2018. The data come from Call Reports for banks and FR Y-9Cs for BHCs. The vertical line represents 2013, the last year before the implementation of the Volcker Rule.

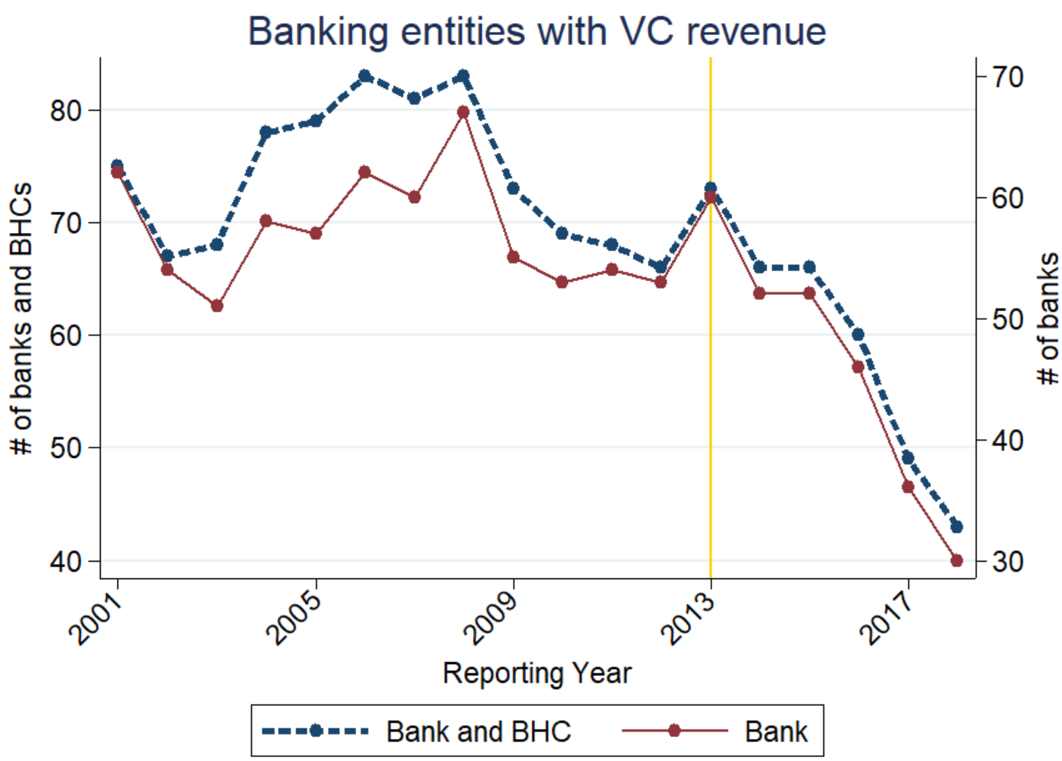
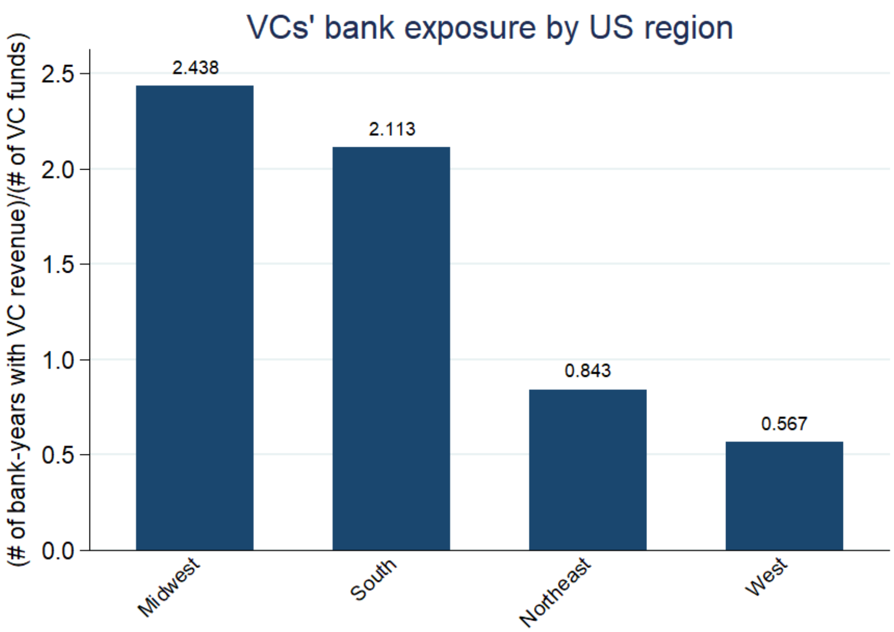


Figure 2: Bank exposure

Panel A plots the average bank exposure by U.S. region. Bank exposure is measured at the state level as the number of bank-years with VC revenue over the 2001–2013 period scaled by the number of VC funds raised in the state during the same period (see Section 2.2). Panel B presents the U.S. map where the shade intensity measures bank exposure. States with no VC funds raised over the 2010–2013 period are white.

Panel A: Bank exposure by U.S. region



Panel B: Bank exposure by U.S. state

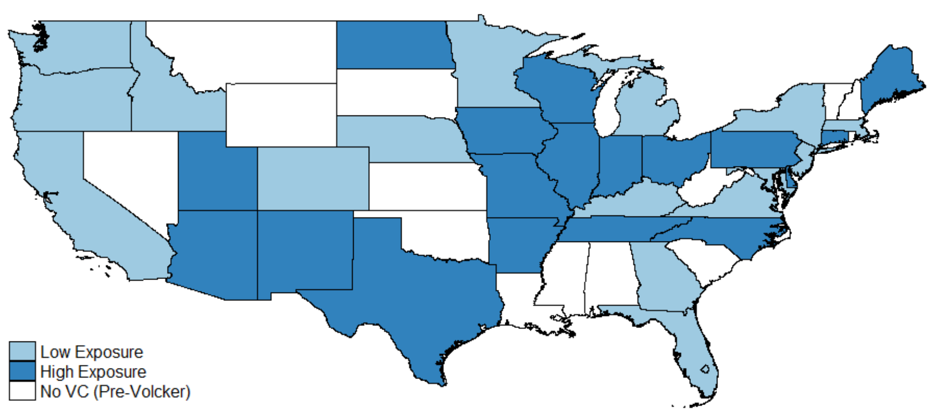


Figure 3: Bank exposure and VC imbalance

This figure presents the scatter plots of the bank exposure variable against state-level VC imbalance as measured by the relative ratio of the number of VC funds raised per capita in a state over the number of VC funds raised per capita in the US over the 2010–2013 period (see Section 2.3).

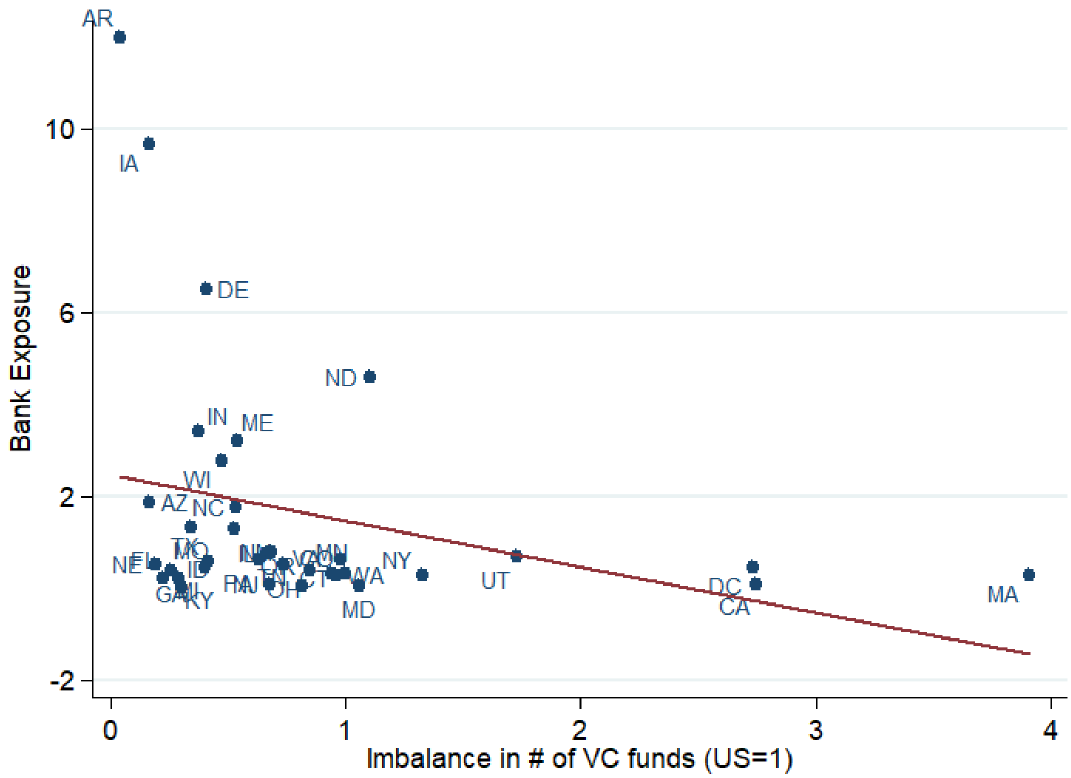


Figure 4: Number of VC funds by vintage year and bank exposure

This figure plots the number of VC funds raised by vintage year for the high and low bank exposure states, respectively. A state is classified as a high-exposure state if its bank exposure is above the median exposure of all states in our sample.

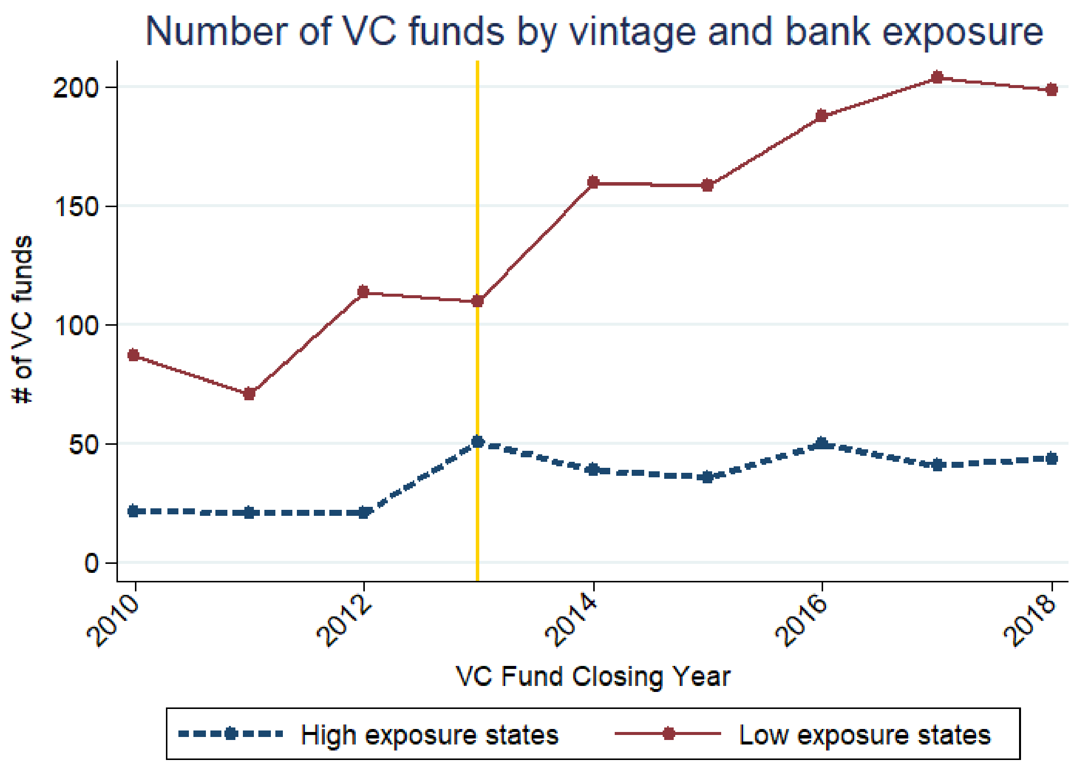


Table 1: Bank exposure and VC activity by state

This table reports the treatment variables by U.S. state (columns 1-2) and each state's imbalance in VC-related activity (columns 3-9). For each state and year, the imbalance is the ratio of a certain VC-related activity per capita in the given state over the activity per capita in the US in that year. These annual ratios are averaged over the 2001–2013 period for each state. Imbalance is computed for the following VC-related activities: the number of VC funds and amount of venture capital raised (columns 3-4), the number of VC-backed startups funded (column 5), the number of all LPs and pension fund LPs investing in VC (columns 6-7), and the number of patents and high-skill employment (columns 8-9). The mean of the treatment variables and imbalance are reported for high- and low-exposure states, as well as each U.S. region.

	Treatment Variables		Imbalance in VC Activity			Imbalance in Capital Supply		Imbalance in Capital Demand	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
STATE	Bank Exposure	High Exposure	VC Funds	VC Capital	VC-bkd Startups	All LPs	Pension LPs	Patents	High-Skill Emp
AR	12.00	1	0.04	0.00	0.06	0.04	0.00	0.10	0.22
IA	9.67	1	0.17	0.01	0.06	0.66	0.95	0.64	0.53
DE	6.50	1	0.41	0.18	0.66	2.38	4.81	6.13	2.49
ND	4.60	1	1.11	0.10	0.00	0.29	0.68	0.16	0.92
IN	3.43	1	0.38	0.12	0.23	0.47	0.55	0.52	0.87
ME	3.20	1	0.54	0.19	0.23	0.29	0.08	0.23	0.63
WI	2.78	1	0.47	0.13	0.24	0.73	0.56	0.66	0.47
AZ	1.86	1	0.17	0.02	0.27	0.23	0.44	0.35	1.54
NC	1.77	1	0.54	0.22	0.31	0.72	0.90	0.49	0.71
MO	1.33	1	0.35	0.17	0.13	0.63	0.36	0.42	0.78
NM	1.29	1	0.53	0.05	0.34	1.20	0.78	0.36	1.64
TN	0.78	1	0.68	0.21	0.33	0.27	0.50	0.26	0.37
IL	0.75	1	0.67	1.02	0.47	1.67	1.46	0.96	0.83
UT	0.68	1	1.73	0.82	0.70	0.47	0.29	0.66	1.11
CT	0.62	1	0.98	2.00	0.77	2.05	1.20	1.83	2.03
PA	0.60	1	0.63	0.41	0.68	1.40	1.15	0.55	0.89
TX	0.57	1	0.42	0.23	0.41	0.56	1.07	0.92	0.80
OH	0.52	1	0.74	0.14	0.29	0.73	0.60	0.65	0.54
NE	0.50	0	0.19	0.01	0.13	0.45	0.63	0.25	0.57
DC	0.45	0	2.73	3.55	2.35	12.25	8.60	4.70	2.79
MI	0.44	0	0.40	0.12	0.25	1.35	1.65	1.20	0.45
GA	0.39	0	0.26	0.09	0.40	0.21	0.36	0.52	0.58
MN	0.36	0	0.85	0.39	0.37	1.61	1.74	1.57	0.74
VA	0.31	0	0.94	0.42	0.53	0.33	0.43	0.34	0.96
CO	0.31	0	1.00	0.64	1.08	0.55	0.77	0.65	1.34
NY	0.29	0	1.33	1.31	1.46	1.87	1.28	1.47	0.59
MA	0.28	0	3.91	5.55	3.91	3.47	3.76	2.04	2.02
WA	0.27	0	0.96	0.85	1.49	0.67	0.72	1.57	2.45
KY	0.22	0	0.29	0.12	0.16	0.23	0.30	0.27	0.18
FL	0.20	0	0.23	0.03	0.17	0.21	0.05	0.27	0.54
CA	0.08	0	2.75	3.27	3.52	1.13	1.26	1.96	1.63
NJ	0.07	0	0.68	1.04	0.49	1.27	1.38	1.31	1.61
OR	0.05	0	0.82	0.12	0.56	0.68	0.69	0.62	1.20
MD	0.05	0	1.06	2.94	0.46	1.78	0.84	0.51	1.54
ID	0.00	0	0.31	0.04	0.09	0.17	0.39	2.55	1.43
High Expo	2.94	1	0.55	0.35	0.38	0.83	0.88	0.71	0.83
Low Expo	0.25	0	1.35	1.50	1.48	1.13	1.09	1.22	1.13
South	2.11	0.45	0.48	0.37	0.35	0.57	0.68	0.59	0.73
Midwest	2.44	0.70	0.54	0.32	0.28	1.04	1.03	0.83	0.66
Northeast	0.84	0.50	1.33	1.60	1.33	1.83	1.54	1.29	1.11
West	0.57	0.38	1.91	2.06	2.34	0.88	0.98	1.50	1.63

Table 2: Summary statistics

This table presents summary statistics of the variables for our analysis at the state-year level (Panel A), the VC fund level (Panel B), and the VC-backed startup level (Panel C). In Panel A, "# VC Funds" is the number of VC funds raised in a given state-year; "# Small/Large Funds" are the count of VC funds with size below and above the sample median in each state; "Total VC Capital" is the aggregate amount of venture capital raised in billions; "Bank Exposure" is the continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. In Panel B, "VC Fund Size" is the size of a fund in billions; "VC Fund Sequence" is the sequence number among all funds raised by a VC firm. "Capital Raised" in Panel C is the amount of venture capital raised in a startup's first VC financing in millions; "Pre-money Valuation" is the pre-money valuation of a startup at the time of its first VC funding in millions.

Panel A: At the state-year level

	N	Mean	Std. Dev.	5- %ile	25- %ile	50- %ile	75- %ile	95- %ile
# VC Funds	315	5.20	15.16	0.00	0.00	1.00	4.00	21.00
# Small Funds	315	2.94	8.92	0.00	0.00	1.00	2.00	11.00
# Large Funds	315	2.25	6.41	0.00	0.00	1.00	2.00	9.00
Total VC Capital	315	0.65	2.08	0.00	0.00	0.04	0.25	3.48
Bank Exposure	315	1.63	2.68	0.05	0.28	0.52	1.77	9.67

Panel B: At the VC fund level

	N	Mean	Std. Dev.	5- %ile	25- %ile	50- %ile	75- %ile	95- %ile
VC Fund Size	1617	0.10	0.15	0.00	0.01	0.03	0.13	0.50
VC Fund Sequence	1617	7.41	17.64	1.00	1.00	2.00	5.00	38.00
Located in CA	1617	0.45	0.50	0.00	0.00	0.00	1.00	1.00
Bank Exposure	1617	0.38	0.77	0.08	0.08	0.27	0.31	1.33

Panel C: At the VC-backed startup level

	N	Mean	Std. Dev.	5- %ile	25- %ile	50- %ile	75- %ile	95- %ile
Capital Raised	11048	4.88	8.50	0.10	1.00	2.10	5.00	18.73
Pre-money Valuation	5903	14.19	28.19	1.63	4.33	7.40	13.75	43.50
Equity Sold	5903	0.29	0.15	0.08	0.19	0.27	0.35	0.59
Syndication Size	11048	2.88	2.15	1.00	1.00	2.00	4.00	7.00
Raised Pre-VC	11048	0.25	0.43	0.00	0.00	0.00	1.00	1.00
Age at Financing	11048	1.92	1.79	0.00	1.00	1.00	3.00	5.00
Series A Round	11048	0.68	0.47	0.00	0.00	1.00	1.00	1.00
Located in CA	11048	0.45	0.50	0.00	0.00	0.00	1.00	1.00
Bank Exposure	11048	0.36	0.79	0.08	0.08	0.27	0.29	0.78

Table 3: Changes in VC fundraising activity

This table presents analyses examining the impact of the Volcker Rule on VC fundraising activity at the state-year level (Panel A), VC fund level (Panel B), and VC firm level (Panel C). Specifically, Panel A reports the diff-in-diff regression results of estimating Eq. (1). The sample period is over 2010–2018 for all columns except columns 4 and 8 in which it is over 2011–2017. In columns 3 and 7, the state of California is excluded from the sample. The dependent variables are the natural log of one plus the number of VC funds raised in columns 1-4, and the natural log of one plus the aggregate amount of venture capital raised in columns 5-8. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. All regressions include state fixed effects and fund closing year fixed effects. Panel B reports the diff-in-diff estimation results of Eq. (1) where the dependent variable is the natural log of VC fund size. The sample period is over 2010–2018 for all columns except column 5, which is over 2011–2017. In column 4, VC funds based in California are excluded from the sample. In column 6, only VC firms that have raised at least one VC fund before and after the Volcker Rule are included. "VC Firm FE" are VC firm fixed effects, "Vintage Year FE" indicate dummies for fund closing year, and "Fund Seq FE" are within-VC-firm fund sequence fixed effects. Panel C reports OLS estimation results of a single-difference regression at the VC firm level. The sample includes VC firms that have raised at least one VC fund over the pre-Volcker period (2010–2013). The dependent variables are dummy variables indicating whether a VC firm has raised a follow-on fund by a certain year between 2014 and 2018 over the post-Volcker period. "Year of Pre-Volcker Fund FE" indicates dummies for the last year the VC firm raised a fund over the pre-Volcker period 2010–2013. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

Panel A: The aggregate of VC fundraising activity

	ln(# VC Funds)				ln(Total VC Capital)			
	(1) All	(2) All	(3) ex. CA	(4) 11-17	(5) All	(6) All	(7) ex. CA	(8) 11-17
Bank Expo × Post	−0.036**	−0.032**	−0.033**	−0.040***	−0.013**	−0.014**	−0.011*	−0.012**
	(0.013)	(0.013)	(0.013)	(0.012)	(0.006)	(0.006)	(0.005)	(0.006)
State GDP growth		−0.006				−0.009		
		(0.010)				(0.010)		
GDP per capita		0.614				1.143*		
		(1.331)				(0.657)		
House price growth		0.014				0.000		
		(0.011)				(0.004)		
STEM emp growth		−0.007				−0.002		
		(0.005)				(0.002)		
Constant	1.080***	−5.577	0.981***	1.105***	0.268***	−12.133*	0.202***	0.272***
	(0.012)	(14.471)	(0.012)	(0.012)	(0.006)	(7.120)	(0.005)	(0.005)
Observations	315	315	306	245	315	315	306	245
Adj. R^2	0.783	0.783	0.685	0.792	0.819	0.820	0.646	0.829
State FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Panel B: VC fund size

	ln(VC Fund Size)					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. CA	11-17	Active VC
Bank Expo × Post	–0.292**	–0.314**	–0.461**	–0.398***	–0.344**	–0.298*
	(0.134)	(0.139)	(0.169)	(0.140)	(0.139)	(0.145)
State GDP growth			–0.060*			
			(0.035)			
GDP per capita			–0.627			
			(2.151)			
House price growth			0.003			
			(0.012)			
STEM emp growth			–0.009			
			(0.007)			
Constant	–3.731***	–3.377***	3.775	–3.614***	–3.441***	–3.101***
	(0.030)	(0.033)	(23.716)	(0.055)	(0.034)	(0.028)
Observations	1,617	1,617	1,617	884	1,265	737
Adj. R^2	0.830	0.777	0.777	0.778	0.782	0.771
VC Firm FE	Y	Y	Y	Y	Y	Y
Vintage Year FE	Y	Y	Y	Y	Y	Y
Fund Seq FE	N	Y	Y	Y	Y	Y

Panel C: Probability of raising a new fund post Volcker Rule

	Raising Fund after the Volcker Rule				
	(1) (By 2014)	(2) (By 2015)	(3) (By 2016)	(4) (By 2017)	(5) (By 2018)
Bank Expo	–0.030***	–0.043**	–0.053**	–0.050*	–0.055**
	(0.010)	(0.019)	(0.023)	(0.027)	(0.027)
Observations	393	393	393	393	393
Adj. R^2	0.031	0.019	0.037	0.050	0.053
Year of Pre-Volcker Fund FE	Y	Y	Y	Y	Y
Mean of Dep. Var.	0.137	0.277	0.387	0.473	0.514

Table 4: The parallel trend assumption

This table presents the estimation results of a dynamic version of Eq. (1) in which the lone interaction variable in Eq. (1) is replaced with a set of interaction variables between the bank exposure variable "Bank Expo" and year dummies; the interaction variable for 2013 is omitted to avoid multi-collinearity. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. The dependent variables are the natural log of one plus the number of VC funds in column 1, the natural log of one plus the total amount of venture capital raised in column 2, the natural log of one plus the number of small VC funds in column 3, and the natural log of one plus the number of large VC funds in column 4. Small vs. large VC funds are defined based on each state's sample median of fund size. All regressions include state-year controls and fixed effects for state and year. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

	ln(# VC Funds)	ln(Total VC Capital)	ln(# VC Funds)	
	(1) All	(2) All	(3) small	(4) large
Bank Expo × 2010	−0.031	0.011	−0.036	0.009
	(0.020)	(0.008)	(0.022)	(0.019)
Bank Expo × 2011	−0.028	0.008	−0.024	0.010
	(0.031)	(0.010)	(0.027)	(0.028)
Bank Expo × 2012	−0.033	0.000	−0.015	−0.017
	(0.026)	(0.008)	(0.037)	(0.028)
Bank Expo × 2014	−0.064***	−0.000	−0.057***	−0.023
	(0.020)	(0.008)	(0.020)	(0.028)
Bank Expo × 2015	−0.062**	−0.018	−0.046	−0.039
	(0.029)	(0.011)	(0.031)	(0.026)
Bank Expo × 2016	−0.042	−0.017*	−0.016	−0.037
	(0.032)	(0.009)	(0.042)	(0.027)
Bank Expo × 2017	−0.067***	−0.006	−0.062**	−0.013
	(0.022)	(0.009)	(0.023)	(0.017)
Bank Expo × 2018	−0.034	−0.005	−0.023	−0.014
	(0.030)	(0.008)	(0.029)	(0.023)
Observations	315	315	315	315
Adj. R^2	0.779	0.817	0.701	0.736
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y

Table 5: LP home bias and availability of alternative LPs

Panel A computes LP home bias by LP type following Hochberg and Rauh (2013). Specifically, we calculate LP's in-state overweighting for each LP type as the share of LP's in-state investments against two benchmarks: 1, the share of all investments that are in the state of the given LP (i.e., BM1); 2, the share of all out-of-state investments that are in the state of the given LP (i.e., BM2). The calculation is done at the investment level in the first three columns, and at the LP-year level in the last three columns, and the mean of LP's in-state overweighting is reported. Panel B examines the heterogeneous effects of the Volcker Rule by the availability of alternative LP assets, which we proxy using a dummy variable "LP Assets" that is equal to one if the total assets under management (AUM) of pension fund and endowment LPs scaled by state GDP is above the sample median, and zero otherwise. The results show a split sample analysis and a triple-difference analysis for two dependent variables: the natural log of one plus the number of VC funds raised in columns 1-3, and the natural log of one plus the aggregate amount of venture capital raised in columns 4-6. The sample period is over 2010–2018 for all columns. All regressions include state-year controls and fixed effects for state and year. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

Panel A: LP home bias

	Home bias est. at the investment level (%)			Home bias est. at the LP-vintage level (%)		
LP type	In-state Share	BM1	BM2	In-state Share	BM1	BM2
Bank	23.2	11.5	11.9	29.3	16.0	16.4
Public Sector Pension	20.8	11.0	11.3	22.6	14.7	14.8
Private Sector Pension	11.2	4.8	4.8	13.5	7.0	7.0
Endowment Plan	12.6	6.7	6.7	13.0	6.8	6.9
Foundation	16.8	7.1	7.3	19.0	9.8	9.9
Insurance Company	20.5	9.3	9.3	19.1	11.0	11.0

Panel B: Heterogeneous effects by the availability of alternative LPs

	ln(# VC Funds)			ln(Total VC Capital)		
	(1) Large LP Assets	(2) Small LP Assets	(3) Large vs. Small	(4) Large LP Assets	(5) Small LP Assets	(6) Large vs. Small
Bank Expo × Post × LP Assets			0.235*			0.035
			(0.129)			(0.037)
Bank Expo × Post	0.002	−0.030**	−0.105**	0.002	−0.006**	−0.024*
	(0.021)	(0.014)	(0.048)	(0.013)	(0.003)	(0.014)
Post × LP Assets			−0.063			0.006
			(0.077)			(0.036)
Constant	−31.862	12.594	−12.046	−31.125**	−2.326	−13.913*
	(20.866)	(16.259)	(16.653)	(11.114)	(4.258)	(8.053)
Observations	153	162	315	153	162	315
Adj. R^2	0.873	0.491	0.782	0.822	0.426	0.819
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y

Table 6: Impacts on startup financing

This table presents diff-in-diff analyses examining the impact of the Volcker Rule on startup financing at the startup level. Panel A has the natural log of capital raised in the startup's first VC funding as the dependent variable. The sample period is over 2010–2018 for all columns except column 5, which is over 2011–2017. In column 4, startups headquartered in California are excluded from the sample. Panel B has the following dependent variables: the natural log of pre-money valuation in column 1, the fraction of equities sold to VC investors in column 2, the natural log of the number of investors (syndication size) in column 3, and a dummy variable indicating whether the startup has received financing from other non-VC investors (e.g., angels or crowdfunding) before its first VC funding in column 4. Panel B includes the same set of fixed effects and controls as column 3 of Panel A. "HQ State FE," "Financing Year FE," "Series A or Seed FE," "Founding Year FE," and "Industry FE" are dummy variables for a startup's headquarters state, year receiving their first VC financing, a Series A or Seed round in its first VC financing, founding year, and industry group, respectively. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by startup headquarters state.

Panel A: First venture capital raised

	ln(Capital Raised)				
	(1) All	(2) All	(3) All	(4) ex. CA	(5) 11-17
Bank Expo × Post	−0.089***	−0.073**	−0.089***	−0.099***	−0.077***
	(0.027)	(0.030)	(0.029)	(0.029)	(0.027)
Constant	0.692***	0.689***	15.746**	0.571***	0.647***
	(0.006)	(0.007)	(7.728)	(0.010)	(0.006)
Observations	11,048	11,048	11,048	6,056	8,999
Adj. R^2	0.083	0.278	0.279	0.293	0.281
HQ State FE	Y	Y	Y	Y	Y
Financing Year FE	Y	Y	Y	Y	Y
Series A or Seed FE	N	Y	Y	Y	Y
Founding Year FE	N	Y	Y	Y	Y
Industry FE	N	Y	Y	Y	Y
Controls	N	N	Y	N	N

Panel B: Additional financing characteristics

	(1) ln(Pre-money Valuation)	(2) Equity Sold	(3) ln(Syndication Size)	(4) Raised Pre-VC Financing
Bank Expo × Post	−0.112***	−0.002	−0.031*	0.013**
	(0.040)	(0.005)	(0.017)	(0.005)
Constant	18.664**	0.611	1.214	−0.957
	(6.841)	(1.281)	(2.344)	(1.967)
Observations	5,903	5,903	11,048	11,048
Adj. R^2	0.207	0.167	0.067	0.112

Table 7: Characterization of startup movers

Panel A presents summary statistics for startup movers identified through Form Ds by destination state. "Offering at Moving" is the total dollar amount of equities offered in millions in the latest Form D; "Frac Already Sold" is the fraction of the offering already sold at the time of filing; "Raised VC" is a dummy variable indicating whether the startup has ever been funded by VC. Panel B presents summary statistics for VC-backed startup movers identified through a combination of Form D and VentureSource data by destination state. "Raised No Fin./Pre-VC/1st VC/2nd VC bf" are dummy variables indicating whether the startup raised no/pre-VC/first VC/second VC financing before moving; "Raised VC after" is a dummy variable indicating whether the startup raised VC financing after moving; "Cap. Raised after" is the total dollar amount of VC financing raised in millions after moving; "Acquired or IPO" is a dummy variable indicating whether the startup exits through M&A or IPO.

Panel A: Startup movers by destination state

	(1) CA		(2) MA		(3) NY		(4) VC hubs	(5) Non-VC hubs	(6) All
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Mean	Mean
Incorporated in DE	0.82	0.39	0.88	0.32	0.81	0.39	0.83	0.74	0.78
Technology	0.50	0.50	0.33	0.47	0.43	0.50	0.45	0.36	0.40
Biotech	0.09	0.28	0.21	0.41	0.07	0.26	0.10	0.11	0.11
Age at Moving	3.64	2.29	3.67	2.52	3.51	2.08	3.60	3.60	3.60
Offering at Moving	9.26	11.54	8.96	15.48	9.87	21.09	9.39	7.55	8.32
Frac Already Sold	0.74	0.32	0.73	0.31	0.72	0.32	0.73	0.64	0.68
Raised VC	0.62	0.49	0.73	0.45	0.60	0.49	0.63	0.47	0.54
Observations	221		78		134		433	603	1,036

Panel B: VC-backed startup movers by destination state

	(1) CA		(2) MA		(3) NY		(4) VC hubs	(5) Non-VC hubs	(6) All
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Mean	Mean
IT	0.37	0.48	0.27	0.45	0.24	0.43	0.31	0.27	0.29
Healthcare	0.21	0.41	0.40	0.49	0.13	0.34	0.22	0.25	0.24
Age at Moving	4.60	2.94	4.96	3.73	4.21	2.80	4.55	5.52	5.07
Raised No Fin. bf	0.08	0.28	0.15	0.36	0.11	0.32	0.10	0.12	0.11
Raised Pre-VC bf	0.05	0.22	0.06	0.24	0.05	0.21	0.05	0.10	0.08
Raised 1st VC bf	0.43	0.50	0.33	0.47	0.46	0.50	0.42	0.32	0.37
Raised 2nd VC bf	0.18	0.39	0.19	0.39	0.12	0.33	0.17	0.15	0.16
Has Revenue bf	0.53	0.50	0.53	0.50	0.54	0.50	0.53	0.56	0.55
Is Profitable bf	0.03	0.17	0.00	0.00	0.04	0.19	0.03	0.03	0.03
Raised VC after	0.59	0.49	0.55	0.50	0.59	0.49	0.58	0.45	0.51
Cap. Raised after	30.52	66.53	21.25	50.53	19.17	55.88	25.49	14.33	19.54
Acquired or IPO	0.16	0.37	0.17	0.37	0.17	0.38	0.17	0.20	0.18
Observations	299		102		170		571	653	1,224

Table 8: Impacts on startups' migration to VC hubs

This table presents diff-in-diff analyses examining the impact of the Volcker Rule on startups' migration to VC hubs at the startup-year level. Specifically, the dependent variables in this table are dummy variables indicating whether a startup has moved its headquarters to CA in Panel A, one of the VC hub states (CA, MA, and NY) in Panel B, and one of the non-VC hub states in Panel C (placebo). In each panel, the sample period is over 2010–2018 for all columns except column 5 (2011–2017). Startups headquartered in CA are excluded from the sample in column 4 of Panel A, and startups headquartered in VC hubs are excluded in column 4 of Panels B and C. In column 6 of each panel, only startups that ever moved to another state over the sample period are included. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. "Incorporation State FE," "Origin State FE," "Year FE," "Founding Year FE," and "Industry FE" indicate dummies for a startup's incorporation state, initial headquarters state, calendar year, incorporation year, and industry. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

Panel A: Startup migration to CA

	Moved to CA					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. CA	11-17	cond. on moving
Bank Expo × Post	0.117***	0.112***	0.108***	0.121***	0.105***	0.775***
	(0.018)	(0.021)	(0.022)	(0.020)	(0.021)	(0.184)
Bank Expo	0.102	0.078		0.013	0.073	0.147
	(0.088)	(0.072)		(0.067)	(0.069)	(0.417)
State GDP growth		−0.051				
		(0.031)				
GDP per capita		0.133				
		(0.317)				
House price growth		−0.030***				
		(0.008)				
STEM emp growth		0.003				
		(0.010)				
Constant	0.304**	−0.883	0.357***	0.499***	0.317**	4.954***
	(0.137)	(3.498)	(0.007)	(0.046)	(0.134)	(1.211)
Observations	56,487	56,487	56,487	39,546	44,380	4,128
Adj. R^2	0.001	0.001	0.003	0.003	0.000	0.009
Incorporation State FE	Y	Y	Y	Y	Y	Y
Origin State FE	N	N	Y	N	N	N
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

Panel B: Startup migration to VC hubs (CA, MA, and NY)

	Moved to VC hubs					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. hubs	11-17	cond. on moving
Bank Expo × Post	0.175***	0.146***	0.152***	0.192***	0.152***	1.081***
	(0.041)	(0.048)	(0.034)	(0.052)	(0.043)	(0.261)
Bank Expo	0.102	0.058		−0.053	0.102	−0.319
	(0.132)	(0.109)		(0.127)	(0.116)	(0.505)
State GDP growth		−0.163**				
		(0.061)				
GDP per capita		0.309				
		(0.597)				
House price growth		−0.046***				
		(0.012)				
STEM emp growth		0.012				
		(0.022)				
Constant	0.661***	−2.132	0.719***	0.962***	0.646***	10.275***
	(0.199)	(6.550)	(0.011)	(0.189)	(0.192)	(1.153)
Observations	56,487	56,487	56,487	28,458	44,380	4,128
Adj. R^2	0.002	0.003	0.007	0.004	0.001	0.015

Panel C: Startup migration to non-VC hubs (placebo)

	Moved to Non-VC hubs					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. hubs	11-17	cond. on moving
Bank Expo × Post	−0.016	−0.037	−0.006	0.023	−0.005	−0.160
	(0.062)	(0.065)	(0.067)	(0.071)	(0.055)	(0.429)
Bank Expo	0.176*	0.181*		0.099	0.150	−0.089
	(0.091)	(0.099)		(0.104)	(0.094)	(0.545)
State GDP growth		−0.089*				
		(0.051)				
GDP per capita		0.360				
		(0.825)				
House price growth		0.001				
		(0.021)				
STEM emp growth		0.034**				
		(0.013)				
Constant	0.986***	−2.995	1.069***	1.092***	0.913***	14.708***
	(0.092)	(9.033)	(0.021)	(0.132)	(0.095)	(1.058)
Observations	56,487	56,487	56,487	28,458	44,380	4,128
Adj. R^2	0.004	0.004	0.005	0.003	0.004	0.018
Incorporation State FE	Y	Y	Y	Y	Y	Y
Origin State FE	N	N	Y	N	N	N
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

Table 9: Startup migration and industry alignment

This table presents triple-difference analyses examining the impact of the Volcker Rule on a startup's migration to one of the VC hub states with its aligned industry at the startup-year level. We proxy the industry alignment by a dummy variable "Dom. Sector" for whether a startup operates in the dominant VC sector in the destination state. The dominant VC sector is the sector in a state commanding the highest VC investment share in the U.S., e.g., technology in CA, and biotech in MA. The dependent variables are dummy variables indicating whether a startup has moved its headquarters to CA in columns 1-2, MA in columns 3-4, and NY in columns 5-6. Startups initially headquartered in the destination state are excluded in each column. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. "Incorporation State FE," "Year FE," "Founding Year FE," and "Industry FE" indicate dummies for a startup's incorporation state, calendar year, incorporation year, and industry. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

	Moved To CA		Moved To MA		Moved To NY	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank Expo × Post × Dom. Sector	−0.046	−0.047	0.126	0.126	0.107	0.119
	(0.097)	(0.096)	(0.111)	(0.111)	(0.090)	(0.090)
Bank Expo × Post	0.144***	0.144***	0.004	−0.000	0.002	−0.032
	(0.038)	(0.036)	(0.020)	(0.021)	(0.021)	(0.022)
Bank Expo × Dom. Sector	−0.022	−0.022	−0.096	−0.097	−0.054	−0.073
	(0.081)	(0.080)	(0.059)	(0.059)	(0.051)	(0.055)
Post × Dom. Sector	0.082	0.087	−0.124	−0.130	−0.091	−0.086
	(0.184)	(0.188)	(0.273)	(0.271)	(0.112)	(0.109)
Bank Expo	0.019	0.027	0.002	−0.003	0.013	0.004
	(0.055)	(0.054)	(0.020)	(0.015)	(0.056)	(0.050)
Constant	0.476***	−2.769	0.156***	−1.674	0.281**	−3.525**
	(0.084)	(2.189)	(0.026)	(1.761)	(0.113)	(1.467)
Observations	39,546	39,546	51,668	51,668	50,218	50,218
Adj. R^2	0.003	0.003	-0.000	0.000	0.002	0.003
Incorporation State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Controls	N	Y	N	Y	N	Y

Table 10: Startup migration and geographic distance

This table examines the impact of the Volcker Rule on startup migration by geographic distance. Specifically, Panel A presents triple-difference analyses by interacting with the (log) geographic distance from a startup to VC hubs, which is the minimal distance between a startup's zip code and the set of VC hub destination states specified in each row. Only coefficients on the triple-interaction term are shown in the table to conserve space. Startups initially headquartered in the destination states are excluded from the sample in all columns. Panel B focuses on the set of startups initially headquartered in non-coastal states. The dependent variables are dummy variables indicating whether a startup has moved its headquarters to CA in column 1, VC hubs in column 2, one of the VC hub states with the shortest distance to the startup in column 3, and one of the coastal states with the shortest distance to the startup in column 4. The sample period is 2010–2018. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

Panel A: Interact with the distance from a startup to VC hubs

	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to MA	(4) Moved to NY
Bank Expo × Post × Dist to CA	−0.004			
	(0.083)			
Bank Expo × Post × Dist to VC hubs		−0.095***		
		(0.023)		
Bank Expo × Post × Dist to MA/NY			−0.037**	−0.060
			(0.018)	(0.037)
Observations	39,546	28,458	51,668	50,218
Adj. R^2	0.003	0.008	-0.000	0.003
Incorporation State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y

Panel B: Move to the closest VC hub

	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to Closest VC hub	(4) Moved to Closest Coastal State
Bank Expo × Post	0.113***	0.196***	0.058	0.046
	(0.022)	(0.059)	(0.035)	(0.030)
Bank Expo	0.035	−0.066	−0.091	−0.092
	(0.072)	(0.141)	(0.087)	(0.082)
Constant	0.398***	0.949***	0.479**	0.395*
	(0.072)	(0.250)	(0.196)	(0.204)
Observations	21,593	21,593	21,593	21,593
Adj. R^2	0.007	0.006	0.001	0.001
Incorporation State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y

Table 11: Startup migration and VC funding constraints

This table presents triple-difference analyses examining the role of financing constraints in driving startups' migration to VC hubs. We proxy financing constraints using a biotech sector dummy in Panel A, startup age in Panel B, and the intensity of VC investments in an industry in Panel C. "Biotech" is a dummy variable equal to one if the startup is operating in the biotech sector, zero otherwise. "ln(Startup age)" is the natural log of startup age. "High VC-funded" is a dummy variable equal to one if the startup operates in a sector with the fraction of startups invested by VCs above the sample median, zero otherwise. The dependent variables in each panel are dummy variables indicating whether a startup has moved its headquarters to CA in column 1, one of the VC hub states (CA, MA, and NY) in column 2, MA in column 3, and NY in column 4. Startups headquartered in the destination states are excluded from the sample in each column. The sample period is over 2010–2018 in all columns. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. "Incorporation State FE," "Origin State FE," "Year FE," "Founding Year FE," and "Industry FE" indicate dummies for a startup's incorporation state, initial headquarters state, calendar year, incorporation year, and industry. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

Panel A: Interact with biotech

	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to MA	(4) Moved to NY
Bank Expo × Post × Biotech	0.268	0.563**	0.125	0.172
	(0.190)	(0.223)	(0.111)	(0.174)
Bank Expo × Post	0.081***	0.101***	0.001	0.013
	(0.017)	(0.027)	(0.019)	(0.020)
Bank Expo × Biotech	−0.170	−0.235	−0.100	−0.019
	(0.102)	(0.148)	(0.063)	(0.060)
Post × Biotech	−0.508*	−0.918*	−0.117	−0.150
	(0.284)	(0.504)	(0.272)	(0.132)
Constant	0.557***	1.012***	0.158***	0.267***
	(0.023)	(0.034)	(0.018)	(0.012)
Observations	39,546	28,458	51,668	50,218
Adj. R^2	0.003	0.009	0.001	0.009
Incorporation State FE	Y	Y	Y	Y
Origin State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y

Panel B: Interact with startup age

	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to MA	(4) Moved to NY
Bank Expo × Post × ln(Startup Age)	0.208***	0.275***	0.014	0.053*
	(0.064)	(0.088)	(0.013)	(0.027)
Bank Expo × Post	–0.137*	–0.174**	0.002	–0.040
	(0.070)	(0.084)	(0.012)	(0.024)
Bank Expo × ln(Startup Age)	–0.048*	–0.061	–0.018*	0.012
	(0.027)	(0.065)	(0.009)	(0.038)
Post × ln(Startup Age)	–0.198	–0.292	–0.032	0.062
	(0.220)	(0.382)	(0.047)	(0.119)
ln(Startup Age)	0.827***	1.633***	0.156	0.479***
	(0.126)	(0.352)	(0.106)	(0.138)
Constant	–0.280	–0.720	–0.002	–0.376*
	(0.250)	(0.522)	(0.111)	(0.214)
Observations	39,409	28,328	51,491	50,042
Adj. R^2	0.004	0.011	0.001	0.010
Incorporation State FE	Y	Y	Y	Y
Origin State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y

Panel C: Interact with the intensity of VC investments in an industry

	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to MA	(4) Moved to NY
Bank Expo × Post × High VC-funded	0.274***	0.271**	0.020	–0.024
	(0.098)	(0.122)	(0.023)	(0.072)
Bank Expo × Post	–0.143*	–0.094	–0.004	0.049
	(0.076)	(0.091)	(0.006)	(0.070)
Bank Expo × High VC-funded	–0.061	–0.000	–0.024	0.077
	(0.109)	(0.133)	(0.016)	(0.051)
Post × High VC-funded	–0.204	–0.172	–0.045	0.066
	(0.179)	(0.264)	(0.056)	(0.171)
Constant	0.217	0.375	0.016	0.190**
	(0.177)	(0.275)	(0.093)	(0.079)
Observations	39,546	28,458	51,668	50,218
Adj. R^2	0.003	0.009	0.001	0.009
Incorporation State FE	Y	Y	Y	Y
Origin State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y

Table 12: The syndication of local and remote VCs

Panel A examines the relationship between the distance from out-of-state (remote) VC investors to a startup and having an in-state VC syndicate. The sample consists of startups' first VC funding and is conditional on having an out-of-state VC investor in the funding. The dependent variable is a dummy variable indicating whether the startup has raised capital in its first VC funding from an investor in the same state as the startup. "Dist from remote VCs to Startup" is the natural log of the distance between the out-of-state VC investors and the focal startup. Panel B presents diff-in-diff analyses examining the impact of the Volcker Rule on having in-state vs. out-of-state VC investors. The dependent variables are: a dummy variable indicating whether the startup has raised capital in its first VC funding from an investor in the same state as the startup in columns 1-2, and from an investor in a different state in columns 3-4. The last two columns present the coefficient difference on the main interaction variable across columns. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by startup headquarters state.

Panel A: Distance of out-of-state VCs and having in-state VCs

	Has In-state VC				
	(1) All	(2) All	(3) All	(4) ex. CA	(5) 11-17
Dist from remote VCs to Startup	0.030**	0.028**	0.028*	0.026*	0.027**
	(0.013)	(0.013)	(0.014)	(0.015)	(0.011)
Constant	0.450***	0.466***	−5.714**	0.426***	0.485***
	(0.093)	(0.097)	(2.322)	(0.104)	(0.080)
Observations	6,365	6,363	6,310	4,460	4,994
Adj. R^2	0.097	0.108	0.110	0.078	0.115
HQ State FE	Y	Y	Y	Y	Y
Financing Year FE	Y	Y	Y	Y	Y
Series A or Seed FE	N	Y	Y	Y	Y
Founding Year FE	N	Y	Y	Y	Y
Industry FE	N	Y	Y	Y	Y
Controls	N	N	Y	N	N

Panel B: Impact on in-state vs. out-of-state VC investors

	Has In-state VC		Has Out-of-state VC		Coef. Diff	
	(1)	(2)	(3)	(4)	(1)-(3)	(2)-(4)
Bank Expo × Post	−0.026***	−0.014**	−0.003	−0.003	−0.023*	−0.024*
	(0.008)	(0.006)	(0.010)	(0.010)	(0.013)	(0.013)
Constant	0.830***	−7.163***	0.516***	1.141		
	(0.002)	(1.423)	(0.002)	(2.308)		
Observations	14,151	14,143	14,151	14,143	28,302	28,286
Adj. R^2	0.081	0.088	0.088	0.094	0.184	0.189
HQ State FE	Y	Y	Y	Y	Y	Y
Financing Year FE	Y	Y	Y	Y	Y	Y
Series A or Seed FE	N	Y	N	Y	N	Y
Founding Year FE	N	Y	N	Y	N	Y
Industry FE	N	Y	N	Y	N	Y
Controls	N	Y	N	Y	N	Y

Internet Appendix A: Venture Capital Revenue

IA.1 Venture capital revenue definition

According to the FFIEC instructions on filing Call Reports or Y-9Cs, bank investments in VC funds with non-controlling stakes should adopt the equity method of accounting. Under this method, the carrying value of a bank's investment in a VC fund is originally recorded at cost but is adjusted periodically to record as income the bank's proportionate share of the fund's earnings or losses and decreased by the amount of cash dividends or similar distributions received from the fund.

Capturing earnings or losses from their VC investments, venture capital revenue is reported by banks on their Call Reports/Y-9Cs as part of non-interest income since 2001. To better understand the sources of this income, consider an example in which a bank invests as an LP into VC fund X. They invest $\$I$ and receive 20% of the fund (i.e., they are 20% of total committed capital), and the bank's equity position in the fund is 20% of all proceeds up to $\$I/0.2$, and 80%*20% of all distributions after $\$I$ is paid back (i.e., 20% carry). The fund has a 2% annual fee on committed capital, i.e., $\$I * 0.02$ is paid by the bank every year. For the bank's VC investments in fund X, we can then analyze whether venture capital revenue will be booked for different types of events.

1. *Capital commitment:* After the bank makes capital commitments to VC fund X and signs the commitment agreement, the bank has a legal liability to pay $\$I$ to the fund over the next 10 years. However, if this commitment does not come with an initial cash transfer, then there will be no accounting entries on the bank's accounting books, and no venture capital revenue booked. On the other hand, if it does come with a cash transfer (as an initial investment), it is equivalent to a capital call (analyzed below). Under the equity method of accounting, the bank will record this initial investment in its long-term equity investment account, but will not book any venture capital revenue.

2. *Management fee:* After VC fund X starts operating, the bank pays the fund $\$I * 0.02$ each year for the cost of managing the fund. Paid out of the original capital commitment $\$I$, the management fee is considered part of the investment cost and will not have a venture capital revenue effect. Therefore, it will not be booked as venture capital revenue.

3. *Capital calls (Drawdown):* Suppose fund X makes a capital call of $\$Z$. After receiving the capital call notice from the fund, the bank will transfer the cash of $\$Z$ to the fund within a given time. Then, the bank will increase the carrying value of its VC investments by $\$Z$ in its long-term equity investment account. In this case, the bank will not book any venture capital revenue. Note that the sum of all calls will be $\$(I - 0.02 * 10 * I)$ (i.e., invested capital).

4. *VC marks up or down the investment:* Suppose at the end of each quarter, VC fund X marks up or down the bank's investment from $\$Z$ to $\$Z + m$, where m can be positive or negative. According to the U.S. Financial Accounting Standards Board (FASB) accounting standards (see Topic 946, the AICPA Audit and Accounting Guide, Investment Companies), VC funds are treated as investment companies for accounting purposes and thus will use the fair value method of accounting. Under this method, when the VC fund marks up or down the investment, the VC fund will record the change on its own accounting books either as income or losses. Because the bank uses the equity method of accounting, it will accordingly record the adjustments $\$m$ as venture capital revenue.

5. *Capital distribution:* Suppose VC fund X sells its investments (e.g., after a portfolio company exit) at a price $\$Z + m + n$ (the bank's proportionate share), and the bank receives a capital distribution (cash) in that amount. In this case, the bank will reduce the carrying value of its VC investments from $\$Z + m$ to 0 in its long-term equity investment account. At the same time, the bank will book the extra $\$n$ (it can be

either positive or negative) as venture capital revenue.

6. *The bank (either partially or fully) sells it position in the fund:* Suppose the bank has a position left in the VC fund at time t with the original book value of $4 * \$Z$ and current carrying value of $\$Y$, and then the bank sells that position in the VC fund for $\$V$. In this case, after the bank sells its position, the bank reduces the carrying value of its VC investments from $\$Y$ to 0 and records the difference between $\$Y$ and $\$V$, i.e., $\$(V - Y)$ as venture capital revenue in its income statement in the period of sale. Note that the venture capital revenue recorded is the difference between the price sold and the current fair value of the bank's VC investment, not the book value. Under the equity method of accounting, the bank adjusts the value of its VC investments over time according to capital calls, capital distribution, and changes in the fair value of VC funds' investments.

In summary, under the equity method of accounting, a bank investing in VC funds will report venture capital revenue when the VC fund reports earnings or losses, e.g., in the case of writing up or down the fund value or making capital distributions. This is also consistent with the FFIEC's direct instruction on how venture capital revenue should be reported (see instructions for item 5.e of Schedule RI – Income Statement of Call Reports):

> In general, venture capital activities involve the providing of funds, whether in the form of loans or equity, and technical and management assistance, when needed and requested, to start-up or high-risk companies specializing in new technologies, ideas, products, or processes. The primary objective of these investments is capital growth.
>
> Report as venture capital revenue market value adjustments, interest, dividends, gains, and losses (including impairment losses) on venture capital investments (loans and securities). Include any fee income from venture capital activities that is not reported in one of the preceding items of Schedule RI, Income Statement.
>
> Also include the bank's proportionate share of the income or loss before extraordinary items and other adjustments from its investments in equity method investees that are principally engaged in venture capital activities. Equity method investees include unconsolidated subsidiaries; associated companies; and corporate

joint ventures, unincorporated joint ventures, general partnerships, and limited partnerships over which the bank exercises significant influence.

Finally, capturing the earnings or losses from VC investments but not the amount of capital allocated to the asset class, venture capital revenue is more representative of banks' VC investment position only when observed in a relatively long window. First, VCs' startup investments are illiquid, and the VC fund's earnings or losses may not be adjusted frequently. Therefore, banks may not report any venture capital revenue quickly. Second, the venture capital revenue reported could exhibit strong cyclic patterns over the life of the VC fund. A VC fund is more likely to have large gains towards the second half of its life, during which more startups will exit (either through IPO or acquisition). Thus, we construct our measure of VCs' bank exposure using venture capital revenue over a relatively long window, 2001–2013, to capture banks' involvement in VC more precisely.

IA.2 Approximating the ideal treatment variable

The ideal treatment variable would use the exact share of capital that banks commit to VC to measure VC firms' exposure to the loss of banks as LPs. Unfortunately, LP commitment data is only available for a subset of LP types, such as public pension funds and insurance companies. Without commitment data for bank LPs, our bank exposure measure is constructed with data available in Call Reports and Y-9Cs. We use the number of bank-years reporting VC revenue scaled by the number of VC funds raised over a given period (see Section 2.2). How does our treatment variable compare with the ideal case? This section shows that our treatment variable is proportional to the ideal case and thus serves as a good proxy.

We start with some notation. Denote the average number of LPs a VC fund typically raises capital from by L, and the average number of VC revenue updates an LP would receive following a VC fund investment by M. Then, within a given period and geography, an ideal treatment variable for VC firms' bank exposure can be constructed and rewritten as follows:

$$
\begin{aligned}
\text{Ideal treatment variable} &= \frac{\text{Dollars raised from bank LPs}}{\text{Total dollars raised in VC funds}} \\
&= \frac{(\text{Avg. commitment size}) * (\text{\# of bank LP commitments})}{(\text{Avg. VC fund size}) * (\text{\# of VC funds raised})} \\
&= \left(\frac{\text{Avg. commitment size}}{\text{Avg. VC fund size}}\right) \\
&* \left(\frac{1}{\text{Avg. \# VC revenue updates per commitment}}\right) \\
&* \left(\frac{\text{Total \# of VC revenue updates for banks}}{\text{\# of VC funds raised}}\right) \\
&= \frac{1}{L} * \frac{1}{M} * \frac{\text{\# bank-years with VC revenue}}{\text{\# of VC funds raised}} \\
&= \frac{1}{L} * \frac{1}{M} * \text{Bank Exposure} \qquad (2)
\end{aligned}
$$

To derive the final line of Eq. (2), we start by rewriting "Dollars raised from bank LPs" as the product of the average commitment size and number of bank LP commitments (line 2). The denominator "Total dollars raised in VC funds" can be rewritten as the product of the average fund size and total number of funds raised. The first key step is to replace "# of bank LP commitments" into the ratio of "Total # of VC revenue updates for banks" to "Avg. # VC revenue updates per commitment" (i.e., M). Recall from the previous section that a bank LP's VC fund commitment will generate VC revenue updates to the bank in the events of capital distribution, and mark-ups (or mark-downs). Therefore, over a given period, the total number of VC revenue updates provided to banks should equal the number of bank LP commitments multiplied by the average number of VC revenue updates per commitment.

Next, we proxy the total number of VC revenue updates for banks by the number of bank-years with VC revenue at the state level (i.e., the numerator in our treatment variable). This proxy is reasonable for several reasons. First, banks have a fixed schedule to report

VC revenue, i.e., filing Call Reports or FR Y-9Cs by quarter and auditing their financial statements by year. Second, banks investing in VC have similar sizes across regions (see column 3 of Table IB.2 Panel B) and thus likely have invested in a similar number of VC funds on average. Lastly, a proxy at the state level can also remove some idiosyncratic differences among banks.

Under the condition that the parameters L and M are constants across regions, Eq. (2) shows that our treatment variable is proportional to the ideal treatment variable and, therefore, provides a good proxy. We next show that L and M do not exhibit significant variations across regions.

Using Preqin data on all LPs' commitments to VC funds, the estimation in Panel A of Figure IB.3 shows that the number of LPs per VC fund (i.e., L) is quite similar across U.S. regions. For example, the median number of LPs per VC fund in the Midwest is 11, while it is 10 in the West. This evidence is consistent with the idea that VC funds often target an optimal number of LPs because too many could create coordination challenges and increase the reporting burden, while too few could increase the risk of losing their investor base and limit their fundraising sources. Note that although the number of LPs per VC fund varies little across regions, the average VC fund size and LP commitment size could vary more. For example, the average VC fund size in the West is about twice as large as that in the Midwest (see Panel B of Figure IB.2). Therefore, it is crucial in Eq. (2) that the ideal treatment variable is proportional to the bank exposure variable with the proportionality constant as a function of the number of LPs (i.e., L) instead of the average VC fund size or LP commitment size. Lastly, we use the number of LPs in each region we estimated to scale our bank exposure variable to define an alternative treatment variable according to Eq. (2) and find robust results in Panel H of Table IB.5 (columns 1-2).

For the parameter M, first notice that VC funds typically have a fixed schedule to provide financial updates to their LPs (i.e., provide financial updates each quarter and audit their financial statements each year).[48] This suggests that the number of VC revenue updates provided to LPs for each investment should be similar across regions. To confirm this, we use Preqin's cash flow data and measure the number of VC revenue updates per LP commitment using VC funds' distribution and value updates with LPs (capital calls do not generate VC revenue updates as illustrated in Section IA.1). Figure IB.3 Panel B shows that the number of VC revenue updates from VC funds does not vary significantly across regions. In particular, VC funds in the Midwest do not generate fewer VC revenue updates than those in other regions, especially in the West. We also directly examine VC fund returns across regions in Table IB.3 using Preqin's fund return data, and find a consistent result: VC funds in the Midwest do not earn significantly lower returns than those in the West. Similarly, we use the number of VC revenue updates in each region we have estimated to scale our bank exposure variable to define an alternative treatment variable according to Eq. (2) and find robust results in Panel H of Table IB.5 (see columns 3-4). Overall, we show that the parameter M does not vary significantly across regions.

Therefore, the small variation in the parameters L and M across regions shows that our treatment variable is proportional to the ideal treatment variable.

[48] See e.g., `https://ilpa.org/wp-content/uploads/2020/07/ILPA-Model-LPA-Term-Sheet-WOF-Version-1.pdf`

Internet Appendix B: Additional Figures and Tables

Figure IB.1: Number of bank-years with VC revenue by U.S. region

This figure presents the number of bank-years with VC revenue by U.S. region based on Call Reports and FR Y-9Cs data from 2001 to 2013.

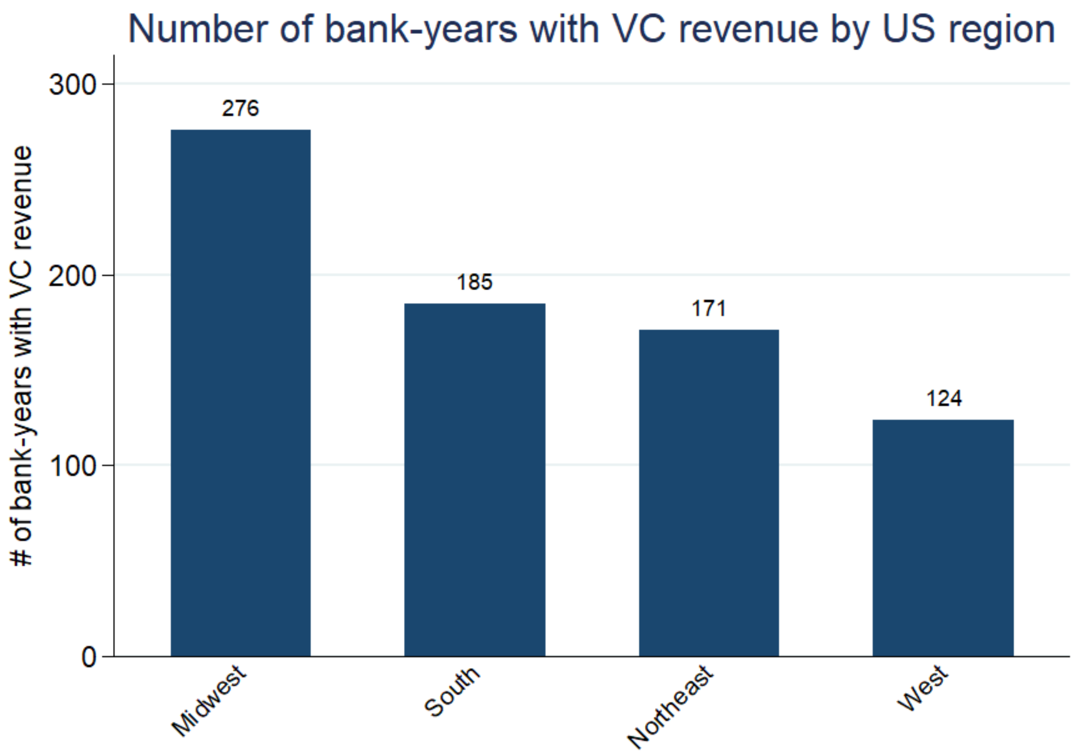
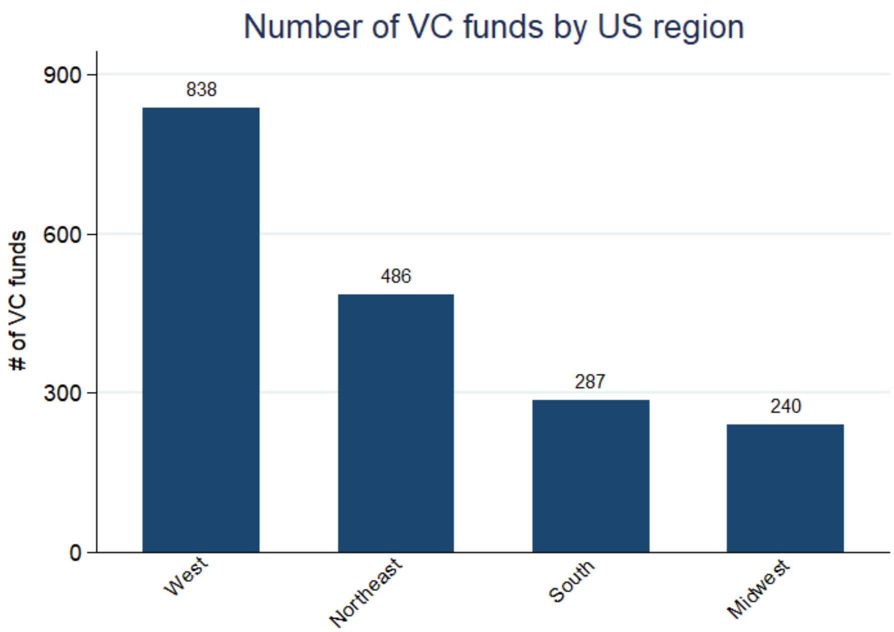


Figure IB.2: VC fundraising by U.S. region

Panel A presents the number of VC funds closed over the 2001–2013 period by U.S. region. Panel B presents the median size (in millions) of VC funds closed over the 2001–2013 period by U.S. region.

Panel A: Number of VC funds



Panel B: Median of VC fund size

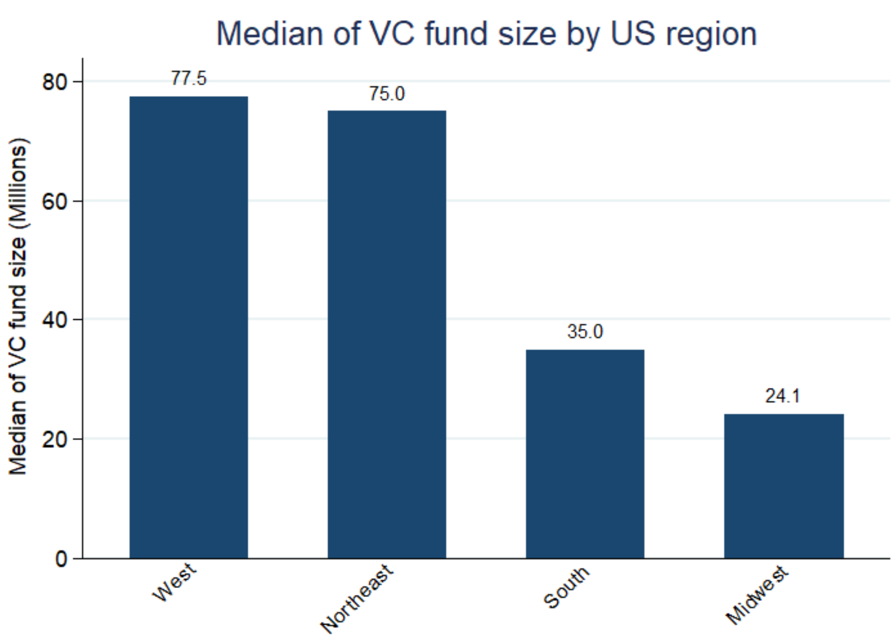
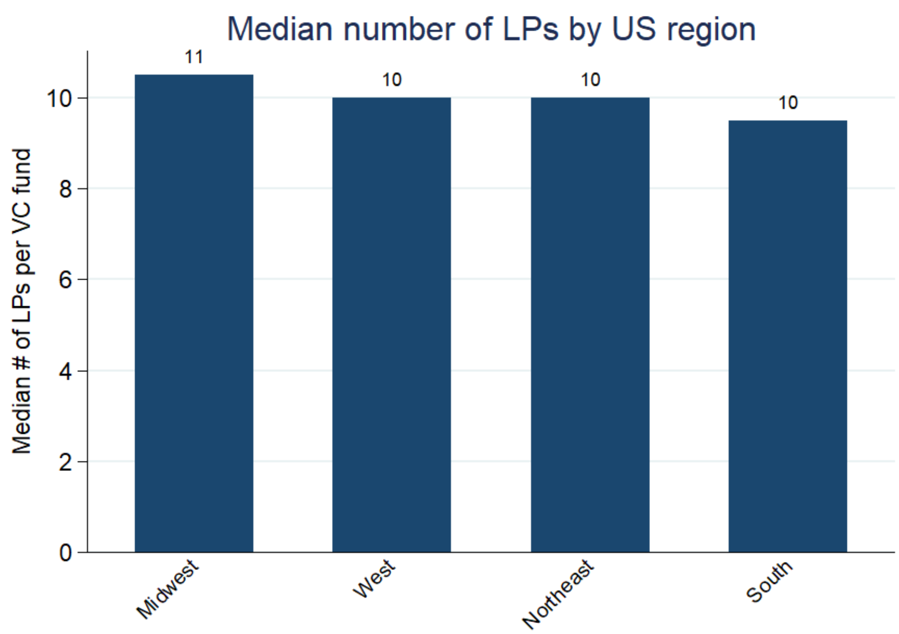


Figure IB.3: Number of LPs and VC fund revenue updates by U.S. region

Panel A presents the median number of limited partners (LPs) per VC fund by U.S. region based on the sample of VC funds included in Preqin. Panel B presents the median number of VC revenue updates (capital distribution and value updates) by U.S. region based on Preqin cash flow data.

Panel A: Median number of VC fund LPs



Panel B: Median number of VC revenue updates

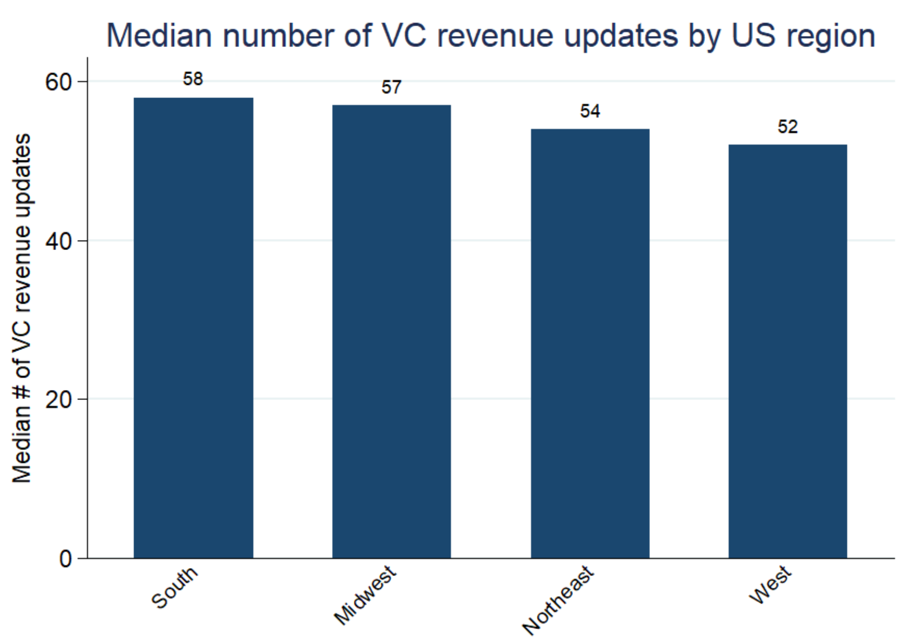
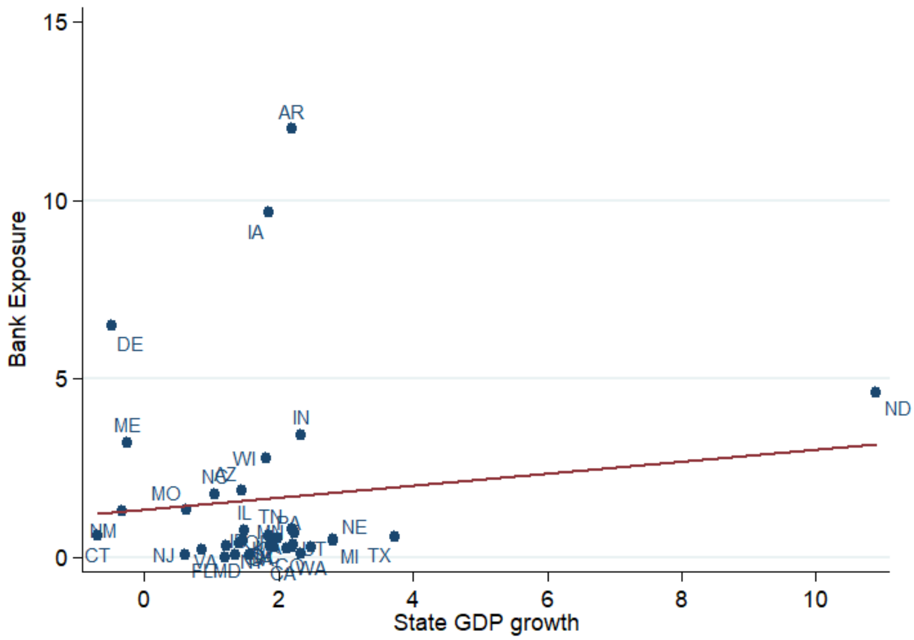


Figure IB.4: Bank exposure and state-level attributes

This figure presents the scatter plots of the bank exposure variable against state attributes: GDP growth in Panel A and log of GDP per capita in Panel B. The state attributes are averaged over the pre-Volcker period 2010–2013 to reduce the influence of outliers, while time-varying analogues of these measures are included as state-year level controls in our regressions.

Panel A: State GDP growth



Panel B: State GDP per capita

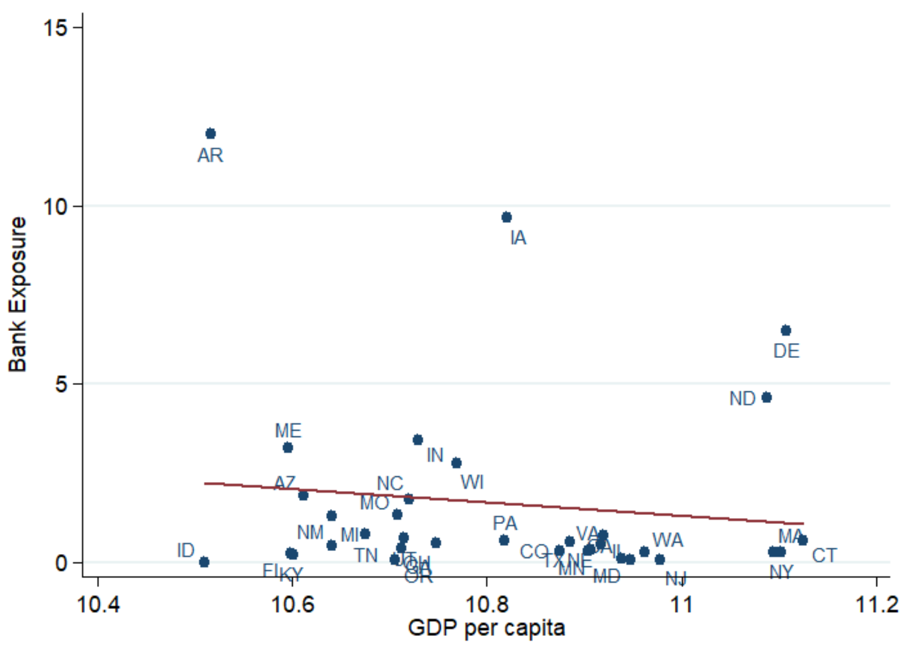


Figure IB.5: Number of VC funds by bank exposure over 2001–2018

This figure plots the number of VC funds raised by vintage year over 2001–2018 for the group of high and low bank exposure states, respectively. A state is classified as a high-exposure state if its bank exposure is above the median exposure of all states in our sample. The vertical line represents 2013, the last year before the implementation of the Volcker Rule.

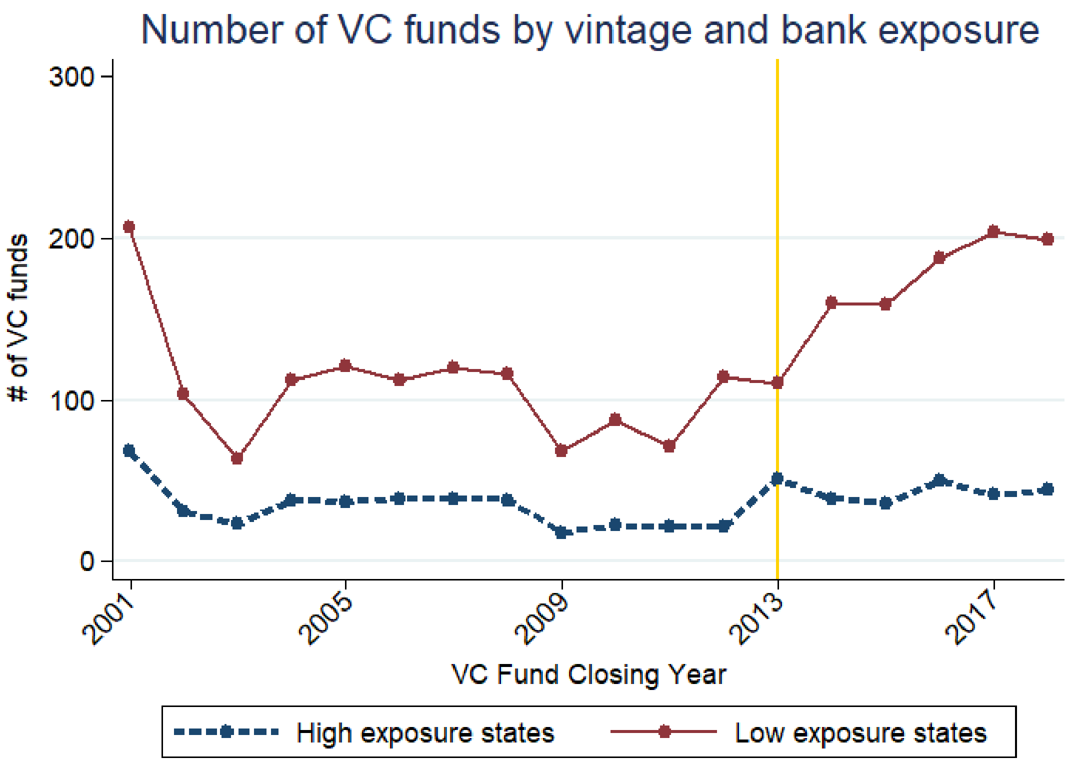
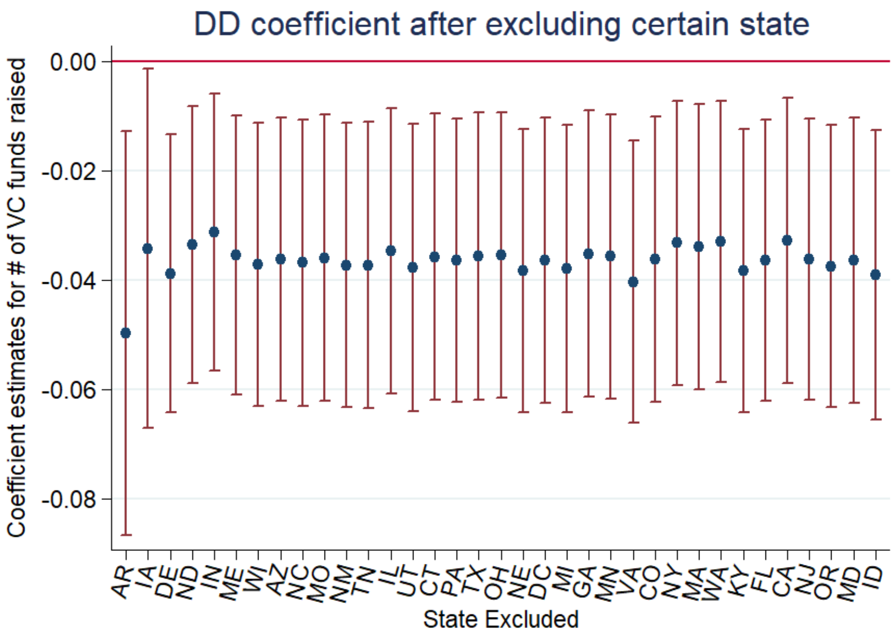


Figure IB.6: Difference-in-difference estimates with one state excluded

This figure provides robustness checks for our main results in Table 3 Panel A and Table 8 Panel A by excluding one state at a time from the regression samples, and plotting the corresponding diff-in-diff coefficient estimates. The vertical red lines represent the 95% confidence interval for the coefficient estimates with standard errors clustered by state.

Panel A: Estimates for the number of VC funds



Panel B: Estimates for startup migration to CA

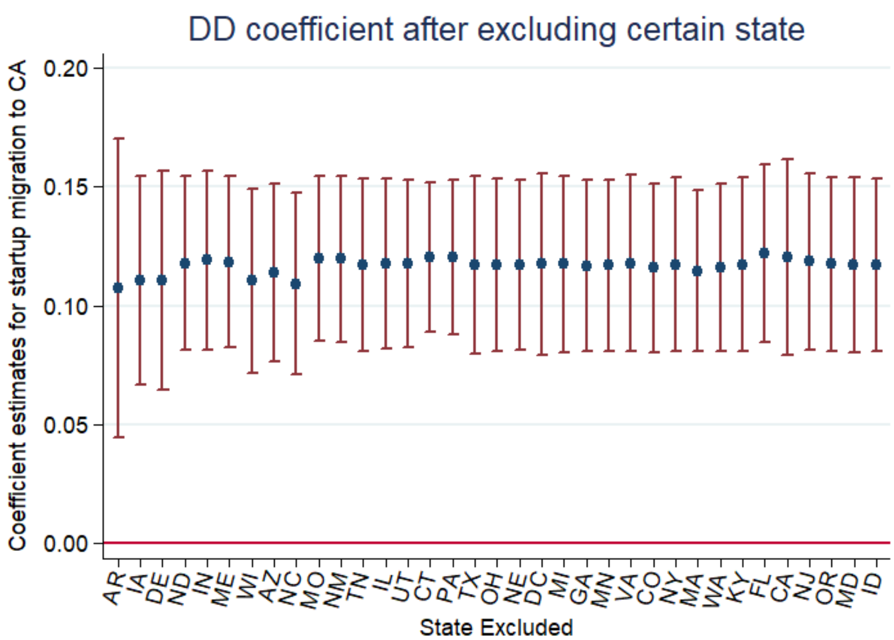


Figure IB.7: Difference-in-difference estimates for first venture capital raised

This figure plots the coefficients for the interaction terms of each financing year, and the bank exposure variable estimated from a dynamic version of Eq. (1). Here, the dependent variable is the log of first venture capital raised and the unit of observation is a VC-backed startup. The 2014 interaction term is the excluded category, reported as zero in the figure. The vertical red lines represent the 95% confidence interval for the coefficient estimates with standard errors clustered by startup headquarters state.

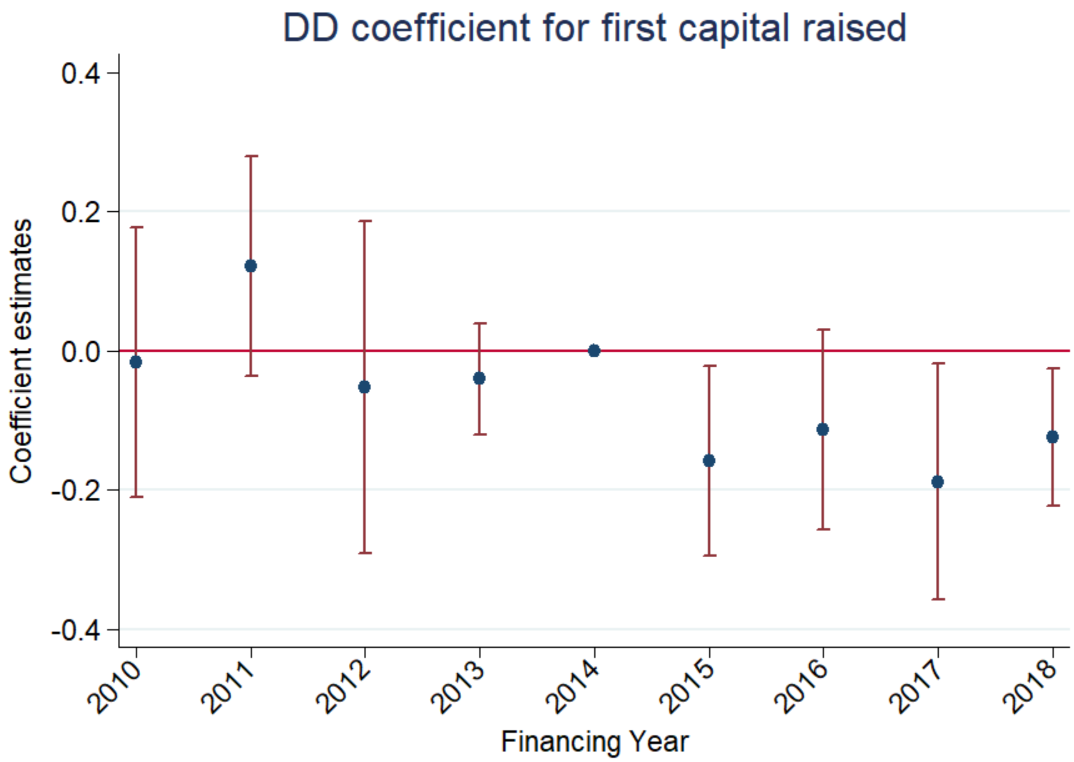


Table IB.1: Summary statistics for banks

The table presents summary statistics of bank characteristics for the sample of banks with and without VC revenue reported over the 2001–2013 period using Call Reports. "Total Assets" is the average of banks' total assets over 2001–2013 in billions; "Total Deposits" is the average of banks' total deposits over 2001–2013 in billions; "No Foreign Office" is a dummy variable indicating whether the bank only has domestic offices; "High/Low Exposure States" are dummy variables indicating whether the bank is located in a state with VCs' bank exposure above/below the sample median; "# Years with VC" is the number of years a bank reports VC revenue over 2001–2013.

Panel A: The sample of banks with VC revenue

	N	Mean	Std. Dev.	5-%ile	25-%ile	50-%ile	75-%ile	95-%ile
Total Assets	174	12.79	66.97	0.05	0.17	0.54	2.07	52.00
Total Deposits	174	5.91	19.68	0.05	0.14	0.47	1.56	27.83
No Foreign Office	174	0.88	0.30	0.00	1.00	1.00	1.00	1.00
High Exposure States	174	0.65	0.48	0.00	0.00	1.00	1.00	1.00
Low Exposure States	174	0.35	0.48	0.00	0.00	0.00	1.00	1.00
# Years with VC	174	3.63	3.54	1.00	1.00	2.00	6.00	12.00

Panel B: The sample of banks without VC revenue

	N	Mean	Std. Dev.	5-%ile	25-%ile	50-%ile	75-%ile	95-%ile
Total Assets	8453	0.80	5.76	0.03	0.09	0.17	0.38	1.88
Total Deposits	8453	0.52	2.50	0.03	0.07	0.14	0.31	1.43
No Foreign Office	8453	0.99	0.10	1.00	1.00	1.00	1.00	1.00
High Exposure States	8453	0.54	0.50	0.00	0.00	1.00	1.00	1.00
Low Exposure States	8453	0.46	0.50	0.00	0.00	0.00	1.00	1.00

Table IB.2: Bank capital share in VC and bank distribution

Panel A estimates a snapshot of banks' investment position in VC and their capital share over total VC funds raised for different subsamples of states. The estimation has the following procedure: (1) for a given group of U.S. states, we estimate the aggregate of banks' net profits from their VC investments using the difference between their positive and negative VC revenue in each year; (2) we then back out banks' investment position in a given year by assuming a fixed annual return of 5%; (3) we scale this estimated banks' investment position by the aggregate of venture capital raised over a fixed window in the past to derive banks' capital share in total venture capital raised in a given year; (4) lastly, we take the annual estimate of banks' investment position and their capital share derived from the previous three steps, and average them over the 2005–2007 period (a relatively stable period between the Dot-com bubble crisis and the 2008 financial crisis). Column 1 reports the estimated banks' investment position in billions. Columns 2-4 report the estimated banks' capital share over total VC funds raised in the past 5, 7, and 10 years, respectively. Panel B reports U.S. bank distribution for different subsamples of states. "# Banks per State" is the total number of banks headquartered in each state; "Avg. Bank Assets (all)" is the average bank assets in a given state in billions; "Avg. Bank Assets (VC)" is the average assets of banks with VC revenue in a given state in billions; "# Banks per Mil Pop" is the total number of banks in a given state scaled by the state population measured in millions; "GDP per capita (K)" is the GDP per capita in thousands in a given state. The estimates in Panel A are based on a combination of Call Reports and Y-9Cs data, and the estimates in Panel B are based on Call Reports data.

Panel A: Banks' capital share in total VC funds raised

	Bank Capital	Bank Capital Share in VC funds		
	Dollars in VC Funds (Billions)	% of Fund $s over [t-4,t]	% of Fund $s over [t-6,t]	% of Fund $s over [t-9,t]
US	27.9	19.7%	9.6%	6.5%
High Exposure States	14.5	59.7%	30.0%	21.1%
Low Exposure States	13.4	11.3%	5.8%	3.7%
Midwest	7.5	61.0%	32.9%	24.0%
South	9.3	57.7%	25.2%	18.2%
Northeast	2.6	5.7%	2.9%	1.9%
West	8.5	12.3%	6.5%	4.0%

Panel B: Bank distribution

	# Banks per State	Avg. Bank Assets (all)	Avg. Bank Assets (VC)	# Banks per Mil Pop	GDP per capita (K)
US	171	3.10	15.65	32.25	54.27
High Exposure States	190	4.55	12.04	38.20	49.39
Low Exposure States	151	1.56	23.10	25.95	59.44
Midwest	273	1.71	12.07	65.04	50.23
South	173	5.45	9.71	24.39	60.29
Northeast	118	2.59	31.90	15.98	58.08
West	81	1.97	13.12	14.26	48.19

Table IB.3: VC fund return by U.S. region

This table presents estimations of VC fund returns by U.S. region based on Preqin VC fund return data. Panel A estimates the average VC fund returns for the Midwest and West regions and presents t-test results of the difference in their returns distribution. Panel B provides similar estimations for a combination of the Midwest and South regions (mainly non-coastal states), and for a combination of the West and Northeast regions (mainly coastal states). The Preqin VC fund returns are net IRR and multiples of committed capital. The sample only includes funds raised before 2010 because VC funds typically have a 10–12 year life, and we want to observe fully realized returns. The estimations are provided for funds raised over a longer period (1990–2010), and also funds raised after the Dot-com bubble crisis (2003–2010).

Panel A: Midwest vs. West

	Midwest		West			
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	P-Value
Net IRR (1990-2010)	5.48	17.04	9.75	30.26	–4.27	0.320
Multiple (1990-2010)	1.43	1.01	1.84	2.81	–0.41	0.294
Net IRR (2003-2010)	7.31	10.85	5.47	15.52	1.83	0.524
Multiple (2003-2010)	1.61	0.89	1.70	1.48	–0.09	0.744

Panel B: Non-coastal vs. coastal regions

	Midwest + South		West + Northeast			
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	P-Value
Net IRR (1990-2010)	6.33	19.33	9.77	39.77	–3.44	0.408
Multiple (1990-2010)	1.51	1.43	1.81	2.78	–0.29	0.310
Net IRR (2003-2010)	7.06	10.78	5.20	16.35	1.86	0.435
Multiple (2003-2010)	1.59	0.83	1.71	1.67	–0.13	0.592

Table IB.4: Falsification tests

This table reports the falsification tests of our diff-in-diff model in Eq. (1) at the state-year level using various measures of economic activities as the dependent variables: bank lending in Panel A, bank health in Panel B, bank concentration in Panel C, and IPO, GDP and LP capital supply in Panel D. The dependent variables in Panel A are the natural log of one plus the amount of bank loans made to one of the following sectors: real estate in column 1, commercial banks in column 2, individuals in column 3, commercial and industrial (C&I) loans in column 4, and total loans in column 5. The dependent variables in Panel B are the ratio of equity over assets in column 1, the ratio of non-performing loans (NPL) over total loans in column 2, the ratio of cash over deposits in column 3, the ratio of total loans over deposits in column 4, and ROA in column 5. The dependent variables in Panel C are the Herfindahl-Hirschman Index (HHI) computed based on bank branch and deposit in columns 1-2, based on BHC branch and deposit in columns 3-4, and concentration ratio computed based on the share of the largest three banks by the number of branches and amount of deposit in columns 5-6. The dependent variables in Panel D are the natural log of one plus the average market valuation of VC-backed IPOs in column 1, the natural log of one plus the number of VC-backed IPOs in column 2, state GDP growth in column 3, the natural log of state GDP per capita in column 4, and the imbalance as measured by the number of all LPs in column 5 and pension LPs in column 6. Standard errors in parentheses are clustered by state.

Panel A: Bank lending

	(1) ln(Loans to Real Estate)	(2) ln(Loans to Commercial Banks)	(3) ln(Loans to Individuals)	(4) ln(C&I Loans)	(5) ln(Total Loans and Leases)
Bank Expo × Post	0.107	0.075	−0.060	0.004	0.001
	(0.387)	(0.059)	(0.040)	(0.019)	(0.011)
Constant	4.992***	4.929***	12.162***	15.969***	18.040***
	(0.352)	(0.054)	(0.036)	(0.017)	(0.010)
Observations	315	315	315	315	315
Adj. R^2	0.698	0.763	0.934	0.871	0.990
State FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

Panel B: Bank health

	Capitalization	Asset Quality	Liquidity		Profitability
	(1) Equity over Assets	(2) NPL over Total Loans	(3) Cash over Deposits	(4) Loans over Deposits	(5) ROA
Bank Expo × Post	0.014	0.001	1.495	1.722	−0.028
	(0.074)	(0.002)	(2.277)	(1.471)	(0.054)
Constant	13.327***	0.002	6.746***	3.130**	0.878***
	(0.068)	(0.001)	(2.068)	(1.336)	(0.049)
Observations	315	315	315	315	315
Adj. R^2	0.981	0.184	0.247	0.013	0.164
State FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

Panel C: Bank concentration

	HHI with banks		HHI with BHCs		Share of Largest 3 Banks	
	(1) By Branch	(2) By Deposit	(3) By Branch	(4) By Deposit	(5) By Branch	(6) By Deposit
Bank Expo × Post	0.011	0.375	0.029	0.350	0.106	0.940
	(0.028)	(0.638)	(0.038)	(0.771)	(0.083)	(0.817)
Constant	5.140***	30.077***	6.142***	34.932***	30.195***	68.233***
	(0.025)	(0.579)	(0.035)	(0.701)	(0.075)	(0.742)
Observations	315	315	315	315	315	315
Adj. R^2	0.992	0.475	0.983	0.516	0.989	0.562
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Panel D: IPO, GDP and LP capital supply

	VC-backed IPO		GDP		Imbalance	
	(1) ln(Avg. MktVal)	(2) ln(# of IPOs)	(3) State GDP Growth	(4) GDP per capita	(5) # of All LPs	(6) # of Pension LPs
Bank Expo × Post	–0.017	–0.011	–0.222	–0.001	–0.029	–0.108
	(0.051)	(0.009)	(0.151)	(0.002)	(0.030)	(0.068)
Constant	2.421***	0.540***	2.226***	10.880***	1.313***	1.236***
	(0.046)	(0.008)	(0.137)	(0.002)	(0.028)	(0.062)
Observations	315	315	315	315	315	315
Adj. R^2	0.497	0.790	0.169	0.991	0.897	0.646
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Table IB.5: Robustness checks for our model and treatment variable

This table provides various robustness checks for our state-year baseline regression by running alternative specifications (Panel A) and constructing alternative treatment variables (Panels B-H). Specifically, in Panel A, with the number of VC funds as the outcome variable, we run a Poisson regression in column 1 and use the inverse hyperbolic sine (IHS) transformation in column 2. In columns 3-4, we transform our treatment variable with the natural log of one plus function. For all other panels, we construct alternative treatment variables by: excluding banks that have ever been involved in a merger as the non-survivor bank from the sample for columns 1-2, and primarily relying on bank holding company's (BHC's) VC revenue data for columns 3-4 in Panel B; including large banks (i.e., those with more than half of their branches out of their HQ state) in the sample for columns 1-2, and excluding large banks with more than half of their deposits generated outside their HQ state from the sample for columns 3-4 in Panel C; using changes in the number of bank-years with VC revenue in each state before and after the Volcker Rule for columns 1-2, and excluding banks with direct VC investment arm from the sample for columns 3-4 in Panel D; using the number of unique banks with VC revenue over 2001–2013 (columns 1-2), and the number of bank-years with VC revenue over 2006–2013 (columns 3-4) as the numerator in Panel E; scaling the numerator of our treatment variable by state GDP, population, the number of patents and STEM employment in Panels F-G; weighting our treatment variable by the number of LPs and the number of VC revenue updates in each region in Panel H. All regressions include state and year fixed effects.

Panel A: Poisson regression and log treatment

	Non-linear Models		Log Treatment	
	(1) Poisson Model	(2) IHS Transf.	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	–0.176**	–0.043**		
	(0.070)	(0.016)		
ln (Bank Expo) × Post			–0.156**	–0.065**
			(0.068)	(0.030)
Constant	3.043***	1.362***	1.106***	0.280***
	(0.017)	(0.015)	(0.026)	(0.011)
Observations	315	315	315	315
Adj./Pseudo R^2	0.815	0.761	0.784	0.820

Panel B: Bank merger and BHCs

	Ex. Merger Banks		Primarily using BHCs	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	–0.046**	–0.015**	–0.036**	–0.013**
	(0.018)	(0.007)	(0.015)	(0.006)
Constant	1.081***	0.267***	1.077***	0.267***
	(0.014)	(0.005)	(0.012)	(0.005)
Observations	315	315	315	315
Adj. R^2	0.784	0.819	0.783	0.819
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel C: Large banks

	Incl. Large Banks		Ex. Large Banks by Dep	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.029**	−0.012**	−0.037**	−0.015**
	(0.012)	(0.005)	(0.016)	(0.007)
Constant	1.080***	0.269***	1.078***	0.268***
	(0.014)	(0.006)	(0.014)	(0.006)
Observations	315	315	315	315
Adj. R^2	0.782	0.819	0.782	0.819
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel D: Banks' direct vs. indirect investments in VC

	Substract Ex Post		Ex. Banks with VC Arm	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.044***	−0.017**	−0.038**	−0.014**
	(0.016)	(0.007)	(0.015)	(0.007)
Constant	1.080***	0.268***	1.080***	0.268***
	(0.012)	(0.006)	(0.013)	(0.006)
Observations	315	315	315	315
Adj. R^2	0.783	0.819	0.783	0.819
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel E: # of unique banks and exclusion of Dot-com bubble period

	# of Unique Banks		Over 2006-2013	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.104***	−0.037**	−0.042**	−0.019**
	(0.032)	(0.017)	(0.016)	(0.009)
Constant	1.076***	0.266***	1.080***	0.271***
	(0.009)	(0.005)	(0.013)	(0.007)
Observations	315	315	315	315
Adj. R^2	0.782	0.819	0.782	0.819
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel F: Scaled by state GDP and population

	GDP		Population	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.608**	−0.351*	−0.922*	−0.582*
	(0.268)	(0.184)	(0.484)	(0.341)
Constant	1.079***	−13.421*	1.072***	−12.905*
	(0.014)	(6.822)	(0.013)	(6.696)
Observations	315	315	315	315
Adj. R^2	0.782	0.821	0.781	0.820
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel G: Scaled by number of patents and STEM employment

	# of Patents		STEM Employment	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.160***	−0.040**	−0.257***	−0.071**
	(0.034)	(0.015)	(0.055)	(0.030)
Constant	1.054***	0.257***	1.081***	0.265***
	(0.001)	(0.001)	(0.002)	(0.001)
Observations	315	315	306	306
Adj. R^2	0.781	0.818	0.777	0.817
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel H: Weight by number of LPs and VC revenue updates

	Wt. by # of LPs		Wt. by # of VC Revenue Updates	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post	−0.343**	−0.131**	−2.133***	−0.786**
	(0.133)	(0.060)	(0.777)	(0.353)
Constant	1.078***	0.268***	1.081***	0.268***
	(0.012)	(0.005)	(0.012)	(0.006)
Observations	315	315	315	315
Adj. R^2	0.782	0.819	0.783	0.819
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Table IB.6: Additional cross-sectional tests

This table provides additional cross-sectional tests of our diff-in-diff model in Eq. (1) by interacting with state VC funding estimated based on Bartik-style measures in Panel A and the size of the state pension in Panel B. In Panel A, we estimate each state's VC funding using their shares of VC funding in the U.S. before the Volcker Rule and the national VC funding. We estimate the number of VC funds raised in a state-year ("Est. # VC Funds") and the total amount of VC capital raised ("Est. Total VC Capital"). We then include "Est. # VC Funds" in columns 1-2 and "Est. Total VC Capital" in columns 3-4 as an additional interaction variable. In Panel B, we include the total state pension assets scaled by state GDP ("State Pension Assets") in columns 1-2 and the interaction between total state pension assets and the fraction of state officials in the funds' boards of trustees scaled by state GDP ("Assets × % Officials") in columns 3-4 as an additional interaction variable. The dependent variables are the natural log of one plus the number of VC funds raised in columns 1 and 3, and the natural log of one plus the aggregate amount of venture capital raised in columns 2 and 4. All regressions include state and year fixed effects. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

Panel A: Interact with Bartik measures of state VC funding

	Est. # VC Funds		Est. Total VC Capital	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post × Est. State Funding	−0.077	−0.004	0.377	−0.264
	(0.048)	(0.013)	(0.771)	(0.734)
Bank Expo × Post	−0.028	−0.015*	−0.025*	−0.006
	(0.017)	(0.008)	(0.013)	(0.005)
Post × Est. State Funding	0.012***	0.007***	0.042	0.051
	(0.003)	(0.002)	(0.072)	(0.064)
Constant	0.783***	0.141*	0.969***	0.087
	(0.195)	(0.080)	(0.113)	(0.146)
Observations	315	315	315	315
Adj. R^2	0.787	0.831	0.790	0.836

Panel B: Interact with state pension

	State Pension Assets		Assets × % Officials	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)
Bank Expo × Post × State Pension	0.343	−0.334	1.796*	−0.331
	(0.448)	(0.275)	(0.952)	(0.399)
Bank Expo × Post	−0.092	0.045	−0.106**	0.003
	(0.079)	(0.045)	(0.046)	(0.015)
Post × State Pension	0.982	1.451	1.729	1.210
	(1.314)	(0.937)	(1.194)	(0.994)
Constant	0.985***	0.126	1.014***	0.228***
	(0.128)	(0.089)	(0.041)	(0.030)
Observations	315	315	315	315
Adj. R^2	0.784	0.823	0.790	0.821

Table IB.7: Changes in the aggregate of VC activity

Panel A reports the OLS regression results of estimating Eq. (1) over 2010–2018 with the natural log of one plus the aggregate amount of capital invested in startups' first VC financings as the dependent variable. Using the same dependent variables as Table 4, Panel B reports the OLS regression results of estimating Eq. (1) over the two years of 2013–2014 around the implementation of the Volcker Rule. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

Panel A: Total capital invested in first VC financings

	ln(Capital Invested in First VC Financings)			
	(1) All	(2) All	(3) ex. CA	(4) 11-17
Bank Expo × Post	−0.008**	−0.007**	−0.006**	−0.007**
	(0.003)	(0.003)	(0.002)	(0.003)
State GDP growth		−0.000		
		(0.001)		
GDP per capita		0.543		
		(0.363)		
House price growth		−0.001		
		(0.001)		
STEM emp growth		−0.001**		
		(0.000)		
Constant	0.127***	−5.772	0.088***	0.127***
	(0.003)	(3.948)	(0.002)	(0.002)
Observations	315	315	306	245
Adj. R^2	0.947	0.949	0.883	0.962
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Panel B: VC fundraising over a narrow window (2013-2014)

	ln(# VC Funds)	ln(Total VC Capital)	ln(# VC Funds)	
	(1) All	(2) All	(3) small	(4) large
Bank Expo × Post	−0.060***	−0.001	−0.053***	−0.018
	(0.021)	(0.007)	(0.019)	(0.026)
Constant	1.178***	0.247***	0.859***	0.681***
	(0.017)	(0.005)	(0.016)	(0.021)
Observations	70	70	70	70
Adj. R^2	0.858	0.875	0.808	0.683
State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y

Table IB.8: Impacts on additional startup financing characteristics

Using the same specifications as Table 6 Panel B, this table presents diff-in-diff analyses examining the impact of the Volcker Rule on additional startup financing characteristics. Specifically, this table reports the OLS regression results of estimating Eq. (1) with the following dependent variables: the natural log of post-money valuation for the startup's first VC funding in column 1, the natural log of capital raised per investor in the startup's first VC funding in column 2, a dummy variable indicating whether the founding team of the startup has a serial entrepreneur in column 3, and the natural log of a startup's age at its first VC funding in column 4. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by startup headquarters state.

	(1)	(2)	(3)	(4)
	ln(Post-money Valuation)	ln(Capital Raised per Investor)	Has Serial Entrepreneur	ln(Startup Age)
Bank Expo × Post	−0.108***	−0.057***	0.001	−0.004
	(0.037)	(0.019)	(0.006)	(0.010)
State GDP growth	−0.005	0.027*	0.003	−0.001
	(0.016)	(0.014)	(0.003)	(0.005)
GDP per capita	−1.632**	−1.338*	−0.228**	0.087
	(0.643)	(0.694)	(0.097)	(0.231)
House price growth	0.002	0.001	0.002	−0.001
	(0.002)	(0.003)	(0.001)	(0.001)
STEM emp growth	0.003	−0.002	−0.000	−0.002
	(0.005)	(0.006)	(0.001)	(0.001)
Constant	20.401***	14.532*	2.667**	0.005
	(7.060)	(7.623)	(1.061)	(2.539)
Observations	5,903	11,048	11,048	11,046
Adj. R^2	0.252	0.252	0.026	0.166
HQ State FE	Y	Y	Y	Y
Financing Year FE	Y	Y	Y	Y
Series A or Seed FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	N
Industry FE	Y	Y	Y	Y

Table IB.9: Characterization of startup movers by treatment

Panel A presents summary statistics for startup movers identified through Form D filings by treatment. "Offering at Moving" is the total dollar amount of equities offered in millions in the latest Form D; "Frac Already Sold" is the fraction of the offering already sold at the time of filing; "Raised VC" is a dummy variable indicating whether the startup has ever been funded by VC. Panel B presents summary statistics for VC-backed startup movers identified through a combination of Form D filings and VentureSource data by treatment. "Raised No Fin./Pre-VC/1st VC/2nd VC bf" are dummy variables indicating whether the startup raised no/pre-VC/first VC/second VC financing before moving; "Raised VC after" is a dummy variable indicating whether the startup raised VC financing after moving; "Cap. Raised after" is the total dollar amount of VC financing raised in millions after moving; "Acquired or IPO" is a dummy variable indicating whether the startup exits through M&A or IPO.

Panel A: Startup movers by treatment

	(1) High-expo to CA		(2) Low-expo to CA		(3) High-expo to VC hubs		(4) Low-expo to VC hubs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Incorporated in DE	0.79	0.41	0.83	0.37	0.81	0.39	0.84	0.37
Technology	0.43	0.50	0.54	0.50	0.39	0.49	0.48	0.50
Biotech	0.09	0.28	0.09	0.28	0.09	0.28	0.11	0.32
Age at Moving	3.91	2.47	3.51	2.20	3.71	2.24	3.56	2.28
Offering at Moving	10.15	12.50	8.84	11.08	10.55	18.51	8.92	14.38
Frac Already Sold	0.67	0.33	0.77	0.31	0.69	0.32	0.75	0.32
Raised VC	0.60	0.49	0.63	0.48	0.60	0.49	0.65	0.48
Observations	70		151		128		305	

Panel B: VC-backed startup movers by treatment

	(1) High-expo to CA		(2) Low-expo to CA		(3) High-expo to VC hubs		(4) Low-expo to VC hubs	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
IT	0.36	0.48	0.37	0.48	0.27	0.45	0.33	0.47
Healthcare	0.23	0.43	0.20	0.40	0.28	0.45	0.20	0.40
Age at Moving	5.06	2.98	4.38	2.91	4.82	2.97	4.44	3.10
Raised No Fin. bf	0.06	0.24	0.09	0.29	0.08	0.28	0.11	0.31
Raised Pre-VC bf	0.06	0.24	0.04	0.21	0.06	0.23	0.05	0.21
Raised 1st VC bf	0.38	0.49	0.45	0.50	0.40	0.49	0.43	0.50
Raised 2nd VC bf	0.24	0.43	0.15	0.36	0.21	0.41	0.15	0.36
Has Revenue bf	0.57	0.50	0.51	0.50	0.58	0.50	0.52	0.50
Is Profitable bf	0.03	0.17	0.03	0.17	0.03	0.16	0.03	0.16
Raised VC after	0.58	0.50	0.59	0.49	0.56	0.50	0.59	0.49
Cap. Raised after	23.63	44.20	33.88	74.92	25.51	65.05	25.47	59.46
Acquired or IPO	0.17	0.38	0.16	0.37	0.16	0.37	0.17	0.37
Observations	98		201		158		413	

Table IB.10: Migration of early-stage VC-backed startups

This table presents diff-in-diff analyses examining the impact of the Volcker Rule on startups' migration to CA using early-stage VC-backed startups retrieved from the VentureSource database. The dependent variable is a dummy variable indicating whether a startup has moved its headquarters to CA in all columns. Startups headquartered in CA are excluded from the sample in column 3. In column 5, only startups that ever moved to another state over the sample period are included. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. "Origin State FE," "Year FE," "First Financing Year FE," "Founding Year FE," and "Industry FE" indicate dummies for a startup's initial headquarters state, calendar year, first VC financing year, founding year, and industry group. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

	Moved to CA				
	(1)	(2)	(3)	(4)	(5)
	All	All	ex. CA	11-17	cond. on moving
Bank Expo × Post	0.106**	0.134***	0.153***	0.124**	1.286**
	(0.045)	(0.038)	(0.041)	(0.051)	(0.487)
Bank Expo	0.000		−0.064	0.004	−0.836
	(0.056)		(0.045)	(0.059)	(0.598)
State GDP growth	−0.056*	−0.038	−0.019	−0.061**	−0.237
	(0.032)	(0.037)	(0.032)	(0.029)	(0.651)
GDP per capita	−0.100	1.966*	−0.017	−0.004	−2.675*
	(0.187)	(1.133)	(0.102)	(0.190)	(1.555)
House price growth	−0.017*	−0.005	0.005	−0.015*	−0.300*
	(0.009)	(0.010)	(0.016)	(0.009)	(0.153)
STEM emp growth	0.022	0.020	0.015	0.028	0.231
	(0.020)	(0.019)	(0.021)	(0.020)	(0.239)
Constant	1.480	−21.365*	0.521	0.387	35.782**
	(2.048)	(12.499)	(1.127)	(2.056)	(16.731)
Observations	60,696	60,696	36,936	49,644	2,819
Adj. R^2	0.001	0.003	0.001	0.001	0.026
Origin State FE	N	Y	N	N	N
Year FE	Y	Y	Y	Y	Y
First Financing Year FE	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y

Table IB.11: Generalized propensity score weighting

This table provides robustness checks using generalized propensity score (GPS) weighting for our main results on the aggregate of VC fundraising (Panel A), VC fundraising at the VC firm level (Panel B), and startup migration (Panel C). GPS is computed based on: all states in our baseline sample in Panel A, VC firms that have raised at least one VC fund before and after the Volcker Rule in Panel B, and all startups in our migration analysis sample in Panel C. In each panel, we employ three types of GPS weighting: inverse probability weighting (IPW) in columns 1-2, stabilized IPW in columns 3-4, and overlap weighting in columns 5-6. The dependent variables in Panel A are the natural log of one plus the number of VC funds raised in columns 1, 3, and 5, and the natural log of one plus the aggregate amount of venture capital raised in columns 2, 4, and 6. The dependent variables in Panel B are the natural log of the median size of VC funds raised by the VC firm in columns 1, 3, and 5, and the natural log of the total VC capital raised by the VC firm before and after the Volcker Rule in columns 2, 4, and 6. The dependent variables in Panel C are dummy variables for a startup's migration to CA in columns 1, 3, and 5, and for a startup's migration to VC hubs in columns 2, 4, and 6.

Panel A: The aggregate of VC fundraising at the state-year level

	Inverse Probability Weighting (IPW)		Stabilized IPW		Overlap Weighting	
	(1) ln(# VC Funds)	(2) ln(Total VC Capital)	(3) ln(# VC Funds)	(4) ln(Total VC Capital)	(5) ln(# VC Funds)	(6) ln(Total VC Capital)
Bank Expo × Post	−0.023**	−0.007**	−0.035**	−0.014**	−0.035***	−0.013**
	(0.009)	(0.003)	(0.013)	(0.006)	(0.013)	(0.006)
Constant	0.408***	0.085***	1.054***	0.261***	1.065***	0.264***
	(0.046)	(0.014)	(0.011)	(0.005)	(0.012)	(0.006)
Observations	315	315	315	315	315	315
Adj. R^2	0.819	0.831	0.774	0.801	0.784	0.818
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Panel B: VC fundraising at the VC firm level

	Inverse Probability Weighting (IPW)		Stabilized IPW		Overlap Weighting	
	(1) ln(VC Fund Size)	(2) ln(VC Capital Raised)	(3) ln(VC Fund Size)	(4) ln(VC Capital Raised)	(5) ln(VC Fund Size)	(6) ln(VC Capital Raised)
Bank Expo × Post	−0.219**	−0.025***	−0.246***	−0.032***	−0.215**	−0.028***
	(0.090)	(0.004)	(0.085)	(0.006)	(0.087)	(0.005)
Constant	−2.972***	0.180***	−2.877***	0.195***	−2.920***	0.190***
	(0.041)	(0.002)	(0.018)	(0.001)	(0.025)	(0.001)
Observations	404	404	404	404	404	404
Adj. R^2	0.811	0.775	0.773	0.760	0.786	0.764
VC Firm FE	Y	Y	Y	Y	Y	Y
Post-Volcker FE	Y	Y	Y	Y	Y	Y

Panel C: Startup migration

	Inverse Probability Weighting (IPW)		Stabilized IPW		Overlap Weighting	
	(1) Moved to CA	(2) Moved to VC hubs	(3) Moved to CA	(4) Moved to VC hubs	(5) Moved to CA	(6) Moved to VC hubs
Bank Expo × Post	0.130***	0.186***	0.117***	0.195***	0.125***	0.183***
	(0.012)	(0.037)	(0.019)	(0.064)	(0.015)	(0.038)
Bank Expo	0.078	0.082	0.116	0.128	0.093	0.095
	(0.082)	(0.126)	(0.105)	(0.159)	(0.085)	(0.129)
Constant	0.302**	0.668***	0.311**	0.670***	0.302**	0.663***
	(0.138)	(0.210)	(0.136)	(0.204)	(0.136)	(0.200)
Observations	56,144	56,144	56,144	56,144	56,144	56,144
Adj. R^2	0.002	0.003	0.001	0.002	0.001	0.002
Incorporation State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y

Table IB.12: Startup migration to Silicon Valley

This table presents a robustness check for our main results in Table 8 by examining startups' migration to VC hubs defined at the MSA level. Specifically, Panel A considers startups' migration to Silicon Valley as defined by a combination of California MSAs: "San Francisco-Oakland-Hayward, CA" and "San Jose-Sunnyvale-Santa Clara, CA". Panel B considers startups' migration to four top VC MSAs in the U.S.: the two MSAs in Silicon Valley as defined above, "Boston-Cambridge-Newton, MA-NH," and "New York-Newark-Jersey City, NY-NJ-PA."

Panel A: Startup migration to Silicon Valley

	Moved to Silicon Valley					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. CA	11-17	cond. on moving
Bank Expo × Post	0.096***	0.091***	0.090**	0.107***	0.081*	0.727**
	(0.032)	(0.032)	(0.036)	(0.032)	(0.042)	(0.285)
Bank Expo	0.076	0.063		0.014	0.039	0.072
	(0.075)	(0.064)		(0.066)	(0.056)	(0.375)
Constant	0.189**	−1.845	0.228***	0.312***	0.210**	3.181***
	(0.091)	(2.390)	(0.011)	(0.041)	(0.092)	(0.846)
Observations	56,487	56,487	56,487	39,546	44,380	4,128
Adj. R^2	0.001	0.001	0.003	0.002	0.000	0.010
Incorporation State FE	Y	Y	Y	Y	Y	Y
Origin State FE	N	N	Y	N	N	N
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Controls	N	Y	N	N	N	N

Panel B: Startup migration to VC hubs

	Moved to VC hubs					
	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	ex. hubs	11-17	cond. on moving
Bank Expo × Post	0.172***	0.139***	0.151***	0.191***	0.151***	1.234***
	(0.037)	(0.040)	(0.037)	(0.048)	(0.036)	(0.290)
Bank Expo	0.057	0.025		−0.061	0.045	−0.579
	(0.121)	(0.100)		(0.125)	(0.102)	(0.499)
Constant	0.591***	−3.441	0.625***	0.796***	0.573***	9.100***
	(0.164)	(4.819)	(0.012)	(0.172)	(0.157)	(0.838)
Observations	56,487	56,487	56,487	28,458	44,380	4,128
Adj. R^2	0.002	0.003	0.006	0.003	0.001	0.016
Incorporation State FE	Y	Y	Y	Y	Y	Y
Origin State FE	N	N	Y	N	N	N
Year FE	Y	Y	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Controls	N	Y	N	N	N	N

Table IB.13: Robustness checks for startup migration to VC hubs

Panel A estimates a dynamic version of Eq. (1) for our startup migration analyses in Table 8. The lone interaction variable in Eq. (1) is replaced with a set of interaction variables between the treatment and year dummies (2013 is omitted). The dependent variables are dummy variables indicating whether a startup has moved its headquarters to: CA in columns 1-2, and one of VC hubs in columns 3-4. Panel B shows the coefficient difference on the main interaction variable across specifications for the startup migration analyses in Table 8. Columns 1-2 show the difference between columns 1-2 of Panel A and columns 1-2 of Panel C, and columns 3-4 show the difference between columns 1-2 of Panel B and columns 1-2 of Panel C. Panel B includes the same set of fixed effects and controls as Panel A in all columns. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by the initial headquarters state of startups.

Panel A: Dynamic regressions

	Moved to CA		Moved to VC hubs	
	(1)	(2)	(3)	(4)
Bank Expo × 2010	0.106	0.191	0.023	0.198
	(0.142)	(0.170)	(0.162)	(0.218)
Bank Expo × 2011	0.014	0.121	0.074	0.280
	(0.072)	(0.117)	(0.126)	(0.195)
Bank Expo × 2012	0.120	0.180	0.119	0.223
	(0.130)	(0.141)	(0.127)	(0.167)
Bank Expo × 2014	0.120	0.177	0.127	0.239
	(0.099)	(0.128)	(0.113)	(0.176)
Bank Expo × 2015	−0.021	0.040	−0.062	0.031
	(0.032)	(0.052)	(0.051)	(0.078)
Bank Expo × 2016	0.378***	0.429***	0.420***	0.486***
	(0.061)	(0.068)	(0.082)	(0.100)
Bank Expo × 2017	0.107	0.139*	0.360	0.394
	(0.068)	(0.080)	(0.247)	(0.271)
Bank Expo × 2018	0.269*	0.324*	0.291**	0.381**
	(0.151)	(0.165)	(0.142)	(0.179)
Observations	56,487	56,487	56,487	56,487
Adj. R^2	0.001	0.002	0.002	0.003
Incorporation State FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Founding Year FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Controls	N	Y	N	Y

Panel B: Coefficient difference for startup migration analyses

	CA vs. Non-VC hubs		VC hubs vs. Non-VC hubs	
	(1)	(2)	(3)	(4)
Bank Expo × Post	0.133**	0.133**	0.191**	0.191**
	(0.064)	(0.066)	(0.073)	(0.078)
Observations	112,974	112,974	112,974	112,974
Adj. R^2	0.005	0.005	0.003	0.004

Table IB.14: Spillover implications on innovation

This table presents diff-in-diff analyses examining the impact of the Volcker Rule on local startup innovation at the state-year level. The dependent variables are the natural log of one plus the count of startups (i.e., firms less than 7 years old) that file a first patent in a given year and belong to one of the following categories: VC-backed startups in columns 1-2, non-VC-backed startups in columns 3-4, and any startup in columns 5-6. The sample period is over 2010–2018 for all columns. The state of CA is excluded from the sample in columns 2, 4, and 6. "Bank Expo" is a continuous treatment variable measuring VCs' reliance on banks for capital before the Volcker Rule. "Post" is set to be one if the observation is after 2014, and zero otherwise. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

	ln(# of VC-backed Startups Filing Patent)		ln(# of Non-VC-backed Startups Filing patent)		ln(Total # of Startups Filing Patent)	
	(1) All	(2) ex. CA	(3) All	(4) ex. CA	(5) All	(6) ex. CA
Bank Expo × Post	−0.027**	−0.026*	−0.005	−0.005	−0.018	−0.018
	(0.013)	(0.014)	(0.020)	(0.021)	(0.020)	(0.020)
State GDP growth	−0.000	−0.001	−0.002	−0.002	0.006	0.006
	(0.019)	(0.019)	(0.012)	(0.012)	(0.012)	(0.012)
GDP per capita	−1.128	−1.440	1.791	1.594	0.376	0.166
	(1.061)	(1.157)	(1.403)	(1.469)	(1.391)	(1.464)
House price growth	−0.001	−0.000	−0.010	−0.012	−0.013	−0.015
	(0.016)	(0.019)	(0.009)	(0.009)	(0.010)	(0.011)
STEM emp growth	−0.002	−0.002	−0.003	−0.003	−0.002	−0.002
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	13.628	16.907	−17.470	−15.419	−1.762	0.426
	(11.526)	(12.558)	(15.250)	(15.965)	(15.116)	(15.901)
Observations	315	306	315	306	315	306
Adj. R^2	0.851	0.784	0.907	0.880	0.918	0.893
State FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y

Table IB.15: State VC funding and startup formation rate

This table examines the relationship between startup formation rate and state VC funding, measured by the number of VC funds raised in Panel A, and the total amount of VC capital raised in Panel B. We estimate a non-linear regression, including quadratic terms of state VC funding. Specifically, "# VC Funds" is the number of VC funds raised in a state-year, and "# VC Funds Squared" is the square of "# VC Funds". "VC Capital" is the total VC capital (in billions) raised in a state-year, and "VC Capital Squared" is the square of "VC Capital". The dependent variables in both panels are the natural log of one plus the count of startups in one of the following categories: any startup in column 1, startups that are formally incorporated in column 2, startups that are incorporated in DE in column 3, startups that are incorporated in DE and operate in the technology sector in column 5, and startups that are incorporated in DE and operate in the biotech sector in column 6. The sample period is over 2010–2018 for all columns. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors in parentheses are clustered by state.

Panel A: Number of VC funds raised

	(1) ln(# of New Startups)	(2) ln(# of Inc. Startups)	(3) ln(# of DE-inc. Startups)	(4) ln(# of Tech. Startups)	(5) ln(# of Biotech Startups)
# VC Funds	1.136***	1.314***	1.421***	1.400***	1.000***
	(0.213)	(0.219)	(0.244)	(0.215)	(0.196)
# VC Funds Squared	−0.076***	−0.086***	−0.094***	−0.092***	−0.062***
	(0.019)	(0.019)	(0.021)	(0.019)	(0.017)
Constant	4.278***	3.045***	2.597***	1.935***	0.666***
	(0.161)	(0.171)	(0.181)	(0.166)	(0.100)
Observations	315	315	315	315	315
Adj. R^2	0.416	0.456	0.466	0.483	0.480
Year FE	Y	Y	Y	Y	Y

Panel B: Total amount of VC capital raised

	(1) ln(# of New Startups)	(2) ln(# of Inc. Startups)	(3) ln(# of DE-inc. Startups)	(4) ln(# of Tech. Startups)	(5) ln(# of Biotech Startups)
VC Capital	0.621***	0.764***	0.862***	0.847***	0.653***
	(0.105)	(0.110)	(0.126)	(0.113)	(0.130)
VC Capital Squared	−0.031***	−0.038***	−0.045***	−0.044***	−0.032***
	(0.008)	(0.009)	(0.010)	(0.009)	(0.010)
Constant	4.418***	3.193***	2.747***	2.083***	0.755***
	(0.168)	(0.175)	(0.181)	(0.169)	(0.097)
Observations	315	315	315	315	315
Adj. R^2	0.305	0.364	0.390	0.407	0.457
Year FE	Y	Y	Y	Y	Y