REStat Fellowship Application

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Summary of Current Research Activity

My research lies at the intersection of labor economics, the economics of science and innovation, and gender. My job market paper examines how local bank failures affect sustained inventor collaboration and team-based innovation. I find that financial shocks reduce both the number of team patents and the likelihood that inventor teams persist. I also study how labor market policies—such as Paid Family Leave (PFL) and Salary History Bans (SHB)—affect the participation and productivity of female inventors in the U.S., highlighting institutional barriers to gender equity in innovation. In a related project, I examine how state-level PFL policies influence mixed-gender collaboration in innovation. Using U.S. patent data and a staggered difference-in-differences design, I find that PFL policies increase the number of mixed-gender patents and male engagement with female inventors. This work highlights the potential of family-friendly labor policies to promote gender diversity and knowledge exchange in innovation teams.

Distinctive Perspective I Can Contribute

I bring a distinctive perspective that bridges labor market policy with the economics of innovation, focusing in particular on gender dynamics within collaborative R&D. My work combines insights from labor economics, applied microeconometrics, and science and innovation studies, using U.S. patent data to study how institutional changes—such as credit shocks or family leave mandates—affect innovative behavior. This intersectional approach allows me to highlight how labor market institutions influence who gets to innovate, under what conditions, and with whom. By focusing not only on individual-level outcomes but also on team-level dynamics and the composition of collaborative innovation, my research contributes a new lens to applied microeconomics. As a woman economist trained at a public university that is underrepresented at the Summer Institute, I also contribute to broadening the diversity of scholarly voices and research agendas in the NBER community.

What I Hope to Gain

By participating in the Summer Institute, I hope to gain critical feedback on my job market paper and related projects, especially on the causal interpretation and broader policy relevance of my findings. I am also eager to connect with scholars who study labor markets, innovation, and gender, and to exchange ideas on how to expand empirical research at the intersection of these fields. I believe this experience will help me refine my research agenda and build long-term collaborative networks. More broadly, I look forward to engaging in conversations that push the boundaries of traditional applied microeconomics, especially those incorporating the role of institutional design in shaping inclusive and effective innovation systems.

Summer Institute Session(s) of Interest

- Innovation
- Labor Studies
- Gender in the Economy

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EDUCATION

Ph.D., Economics, University at Albany, SUNY — 2025 (expected)
Committee: Chun-Yu Ho (Co-Chair), Gerald R. Marschke (Co-Chair), and Pinka Chatterji

M.A., Economics, Sungkyunkwan University, Seoul, South Korea — 2016

B.A., Economics, Hongik University, Seoul, South Korea — 2014

RESEARCH INTERESTS

Labor Economics, Economics of Science and Innovation, Applied Microeconomics

WORKING PAPERS

"The Effect of Credit Shocks on Sustained Team Collaboration in Patenting" **(*Job Market Paper*)**

"Bridging Gender Innovation Gap with Paid Family Leave Policies," with Chun-Yu Ho, Gerald R. Marschke, and Won Sung (*Draft available upon request*)

WORK IN PROGRESS

"Paid Family Leave and Mixed-Gender Collaboration in Innovation," with Chun-Yu Ho and Gerald R. Marschke

"Barriers or Benefits? Salary History Bans and Startup Innovation," with Won Sung

"Patent Families and Novelty: Beyond Filing Dates," with Gerald R. Marschke

PUBLICATION

Noh, K. (2024). "Paid Family Leave Policy and Leave-Taking: A Synthetic Control Approach." ***Applied Economics Letters***, 1-5.

RESEARCH EXPERIENCE AND PROFESSIONAL DEVELOPMENT

Attendee NBER Innovation Information Initiative Technical Working Group Meeting — December 2024

Funded Attendee NBER Innovation Research Boot Camp — July 2023

Research Associate Bank of Korea Economic Research Institute, Seoul, South Korea — May 2017 - August 2017

Research Associate Korea Development Institute, Sejong, South Korea — July 2016 - May 2017

TEACHING EXPERIENCE

Instructor, University at Albany, SUNY

Intermediate Microeconomics (UG) — Summer 2023-2024
Principles of Economics II: Macroeconomics (UG) — Spring 2023-2024
Principles of Economics I: Microeconomics (UG) — Fall 2021-2024, Summer 2022, Winter 2024, Spring 2025

Teaching Assistant, University at Albany, SUNY

Labor Economics (UG)	Spring 2022
Principles of Economics I: Microeconomics (UG)	Fall 2020, Spring 2021
Economics Department Tutor (UG)	Spring 2020
Financial Economics (UG)	Fall 2019

CONFERENCE PRESENTATIONS (* DENOTES SCHEDULED)

2025: Eastern Economic Association Conference (New York), University of San Diego School of Law Patent Conference* (San Diego)

2024: Eastern Economic Association Conference (Boston), Midwest Economics Association Conference (Chicago), International Conference on the Science of Science and Innovation (Poster, Washington D.C.), Annual Meeting of the Academy of Management (Chicago), Southern Economic Association Conference (Washington D.C.)

2023: Eastern Economic Association Conference (New York), American Society of Health Economists Conference (St. Louis), Western Economic Association International Conference (San Diego), Association for Public Policy Analysis and Management Conference (Atlanta)

2022: Association for Public Policy Analysis and Management Conference (Washington D.C.)

FELLOWSHIPS, GRANTS, AND AWARDS

I3 Open Data Fellowship, NBER Innovation Information Initiative (I3)	2025
Individual Development Award, State of New York and United University Professions ($456)	2024
Helen Horowitz Award for Outstanding Teaching, University at Albany, SUNY	2023
Individual Development Award, State of New York and United University Professions ($1,323)	2023
Center for Aging and Policy Studies Travel Grant ($1,182)	2022
Graduate Assistantship, University at Albany, SUNY	2019-2022, 2024

OTHER INFORMATION

Skills: Stata, R, QGIS, LaTeX

Languages: English (fluent), Korean (native)

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REFERENCES

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The Effect of Credit Shocks on Sustained Team Collaboration in Patenting

(*Job Market Paper*)

This paper examines the impact of bank failures on team-based innovation, focusing on the persistence of inventor teams under credit supply constraints. Using U.S. patent and FDIC data from 2000 to 2012, we present three main findings. First, we show that bank failures significantly reduce both the number of team patents and the number of inventors with collaborators. Second, we find that negative banking shocks decrease the likelihood that inventor teams remain together for projects in subsequent periods. However, we provide evidence that team-specific factors, including geographic proximity, prior collaboration experience, and smaller team sizes, mitigate the adverse effects of bank failures and help preserve the stability of co-authorship. Our findings suggest that limited capital availability during bank failures can disrupt the continuity in teamwork, but the effects vary across inventor teams. This study offers important and timely policy insights into how credit supply disruptions influence joint production and the stability of teamwork in innovation processes.

Bridging Gender Innovation Gap with Paid Family Leave Policies

(*with Chun-Yu Ho, Gerald R. Marschke, and Won Sung)*

This study examines the impact of state-mandated paid family leave (PFL) policies on female inventors' participation and productivity in patenting activities, focusing on differences between privately held and publicly traded U.S. firms. Using U.S. patent records from 1994 to 2019 and a staggered difference-in-differences approach, we present four key findings. First, state PFL policies significantly increase female participation and productivity, particularly in private firms where employer-sponsored leave benefits are typically limited. Second, a decomposition analysis reveals that the increase in female patenting is primarily driven by participation effects. Third, these participation effects are most prominent among early-career inventors and female inventors contributing to lower-quality patents. Fourth, productivity effects, while secondary, appear to be driven by female inventors transitioning from public to private firms and those producing patents of below-median quality. Our findings suggest that state PFL policies can complement employer-sponsored benefits, playing a critical role in reducing gender disparities in innovation, particularly in firms where support systems are limited or absent.

Paid Family Leave Policy and Leave-Taking: A Synthetic Control Approach

(*Applied Economics Letters, 2024)*

This article estimates the effect of California's Paid Family Leave (CA-PFL) program on young women's leave-taking. Using the synthetic control method, this study finds that women of childbearing age are more likely to be on leave after the implementation of the policy.

Updated February, 2025

The Effect of Credit Shocks on Sustained Team Collaboration in Patenting*

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December 5, 2024

[Link to the latest version]

Abstract

This paper examines the impact of bank failures on team-based innovation, focusing on the persistence of inventor teams under credit supply constraints. Using U.S. patent and FDIC data from 2000 to 2012, we present three main findings. First, we show that bank failures significantly reduce both the number of team patents and the number of inventors with collaborators. Second, we find that negative banking shocks decrease the likelihood that inventor teams remain together for projects in subsequent periods. However, we provide evidence that team-specific factors, including geographic proximity, prior collaboration experience, and smaller team sizes, mitigate the adverse effects of bank failures and help preserve the stability of co-authorship. Our findings suggest that limited capital availability during bank failures can disrupt the continuity in teamwork, but the effects vary across inventor teams. This study offers important and timely policy insights into how credit supply disruptions influence joint production and the stability of teamwork in innovation processes.

Keywords: Bank Failures, Innovation, Team Persistence, Teamwork, Patent

JEL Codes: G21, G33, O32

*We thank the participants of the 2023 Association for Public Policy Analysis and Management (APPAM) conference, the 2024 Eastern Economic Association (EEA) conference, the 2024 Midwest Economics Association (MEA) conference, the 2024 International Conference on the Science of Science and Innovation (ICSSI), the 2024 Academy of Management (AOM) conference, and the 2024 Southern Economic Association (SEA) conference for their valuable comments. All errors are our own.

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1. Introduction

In the first half of 2023, the U.S. experienced a series of significant bank failures due to bank runs, including the collapses of First Republic Bank, Silicon Valley Bank (SVB), and Signature Bank. The collapse of the first two California-based banks marked the second and third largest bank failures in U.S. history, following the collapse of the Washington Mutual Bank in 2008. The failure of SVB, in particular, had significant consequences beyond the financial sector, profoundly affecting the technology industry. As a primary financial services provider and lender to startups and tech companies, SVB's failure disrupted the innovation ecosystem in the United States.

The negative effects of financial frictions on innovation have been explored in numerous recent studies, with empirical evidence underscoring the crucial role of bank-based finance in corporate innovation (e.g., Contreras et al., 2021; Nanda and Nicholas, 2014; Spatareanu et al., 2019). Despite the increasing trend of teamwork in innovation (Toole et al., 2019), however, there is limited understanding of how local credit constraints impact team-based innovative activities and the accumulation of team-specific human capital. This paper utilizes U.S. patent data and local-level variations in the branches of failed banks to examine the effect of bank failures in the U.S. on the size of team innovation during the period from 2000 to 2012. Additionally, we investigate the dynamics of teamwork evolution within firms following local bank failures, providing empirical evidence on how firms allocate their pool of human capital across multiple team projects when confronted with limited capital availability due to these failures.

Technological innovation increasingly occurs in teams. The average number of inventors listed on U.S. patents has risen from 1.7 in 1975 to 2.6 in 2000, with more than two-thirds of U.S. patents filed in 2000 involving multiple inventors (Kim, 2022). As inventors increasingly work in teams, firms in technology fields where teamwork is critical may strive to preserve

their valuable team-specific human capital by hiring inventors in groups rather than individually. However, if local bank failures restrict the pool of available funds to firms, it can hinder their ability to hire entire teams. Consequently, exposure to a bank failure may force firms to cut some team projects, allowing only a subset of inventor teams to continue generating follow-on innovations together.

This paper explores the continuation of collaborative relationships in innovation beyond the initial team formation for several reasons. First, it is efficient to preserve co-authorships with existing co-inventors once a team is successfully created, as building team-specific human capital in newly formed teams takes time. Second, accumulated team-specific capital enhances productivity by reducing moral hazard and increasing trust between team members (Jaravel et al., 2018). Third, firms can reduce coordination costs if teams remain together for subsequent projects. To investigate how inventors continuously retain their co-authorships with the same colleagues, we decompose inventor teams into all possible pairs of U.S. inventors, where a pair is defined as a unique combination of two inventors listed on a patent. In this analysis, each inventor pair enters the sample once, and we assume a pair has stable teamwork if they continue inventing follow-on patents together within the next three years at the same firm. This approach allows us to study how pairwise teamwork evolves within a firm when facing negative banking shocks.

To identify the effect of local bank failures on team stability, we construct a novel combination of several data sources. Three key features of the data enable us to study whether bank failures affect the likelihood that inventor pairs continue working together in subsequent periods at the same firm. First, we construct a unique inventor pair-firm-year panel for U.S. publicly traded firms by tracking inventors' patenting histories. This data captures dynamic connections between inventors working in teams over the study period, allowing us to create various measures of team-specific capital for each inventor pair, such as physical distance between inventors and shared work experience. Second, our focus on team innova-

tion provides a direct way to measure accumulated team-specific capital through a measure of team stability, indicating the continuation of collaborative relationships with the same co-inventors. Third, this data allows us to exploit variations in commercial bank failures, which serve as exogenous shocks to firms' access to external funding. Given that adjacent counties, which are economically and socially integrated, have similar patterns of bank lending and investment, we use geographical variations in bank failures at the Core-Based Statistical Area (CBSA) level, as defined by the U.S. Office of Management and Budget.

Our empirical strategy consists of two main parts. First, using firm-year level data, we conduct tests to examine if exposure to bank failures is associated with reductions in team innovation. This includes examining the number of patents produced by inventor teams, the average team size, and the number of inventor pairs who produce co-inventions. The number of team patents reflects the quantity of team innovation output, while team size and the number of inventor pairs indicate the stock of team-specific human capital as an input in the team innovation process. The second part of our analysis focuses on the likelihood that inventor pairs maintain their collaborative relationships over time within a firm in the event of bank failures. We explore various types of team-specific capital associated with team stability to understand the heterogenous effects of bank failures on subsequent innovation at the inventor pair level. To investigate the role of team-specific capital in team stability, we construct four measures that capture different aspects of team-specific capital: (a) whether team members are less geographically dispersed, (b) whether the teammates have worked together in the past, (c) whether the team includes at least one female inventor, and (d) whether the team size is small.

This paper presents three main findings. First, firms tend to scale down team innovation during periods of banking shocks, as reflected in a decline in both the number of team patents and the number of unique inventor pairs collaborating. This suggests that local financial frictions depress team-based patenting activities and lead to a loss of team-specific

human capital. Second, we show that negative banking shocks significantly disrupt the continuity of teamwork, indicating that some inventor pairs discontinue their collaboration in subsequent periods. This effect, however, is mitigated when inventor pairs are geographically closer, have accumulated team-specific human capital through past collaboration, or work in smaller teams of two or three inventors. These findings suggest that limited capital availability during bank failures reduces the likelihood of repeated collaboration with the same co-inventor. Nonetheless, the effects depend on factors such as geographic proximity, past collaboration, and team size, which play a crucial role in maintaining team stability. In contrast, we find that gender composition does not significantly affect team stability during bank failures.

To ensure that our findings are not driven by unobserved common factors, we conduct a series of robustness checks. First, we exclude observations from CBSA regions where a bank headquartered in the same local market collapses, addressing concerns that the observed bank failures might stem from poor local economic conditions. Second, we omit observations for firms based in California, which comprises the largest number of firms in our sample. Third, we re-estimate results excluding the financial crisis years of 2007-2009. Fourth, we present results after removing inventor pairs with unknown gender from the sample. As an additional sensitivity analysis, we use alternative time windows for follow-on inventions to measure team stability. Finally, we employ a continuous measure of bank failures to capture the differential effects of varying failure intensities. Across all these robustness checks, our main results remain consistent and robust.

This paper contributes to three strands of literature. First, our work adds to the body of research examining the real effects of bank failures (e.g., Anari et al., 2005; Ashcraft, 2005; Bernanke, 1983; Calomiris and Mason, 2003; Kandrac, 2014). Studies such as Ashcraft (2005) and Kandrac (2014) demonstrate that bank failures negatively affect local economic activity. Second, this paper closely relates to the literature exploring the relationship between local

financial frictions and innovation. Prior research has primarily demonstrated that negative bank shocks reduce aggregate patent production at the firm level (e.g., Contreras et al., 2021; Nanda and Nicholas, 2014; Spatareanu et al., 2019). This paper extends the current understanding by investigating the impact of bank failures on team-based innovation, identifying disrupted teamwork as a key mechanism driving these outcomes. Our findings are consistent with Jaravel et al. (2018), which emphasizes the critical role of accumulated R&D team capital in innovation processes. Third, our study enhances understanding of the role of team-specific capital in collaborative relationships between inventors. The literature on team innovation highlights the importance of factors such as shared work experience, co-location, gender, and team size in shaping innovative outcomes (e.g., Baghai et al., 2019; De Dreu, 2006; Fay et al., 2006; Jaravel et al., 2018; Peltokorpi and Hasu, 2014; Tahmooresnejad and Turkina, 2022; Whittington, 2018). Our contribution is the identification of the comprehensive role of team-specific capital associated with repeated collaboration, providing insights into which types of inventor pairs are more vulnerable under credit supply constraints.

The remainder of this paper proceeds as follows. Section 2 provides relevant literature. Section 3 develops our hypotheses, and Section 4 describes the construction of the inventor pair-firm-year panel data for U.S. publicly traded firms and empirical framework. Section 5 presents the baseline results. Section 6 provides the results of several robustness checks. Section 7 concludes.

2. Related Literature

2.1. Financial Frictions and Innovation

Our study relates to the literature examining the real effects of bank failures. Prior research has extensively investigated the negative effects of bank failures on economic activity

during the Great Depression (Anari et al., 2005; Bernanke, 1983; Calomiris and Mason, 2003; Ziebarth, 2013) and the recent global financial crisis of 2007 to 2009 (Ghosh, 2017; Kandrac, 2014). For instance, Bernanke (1983) found that deposits in failed banks significantly reduced the growth rate of industrial production at the national level. More recently, Kandrac (2014) and Ghosh (2017) provided evidence that bank failures during the recent financial crisis adversely affected state or county-level economic outcomes, as measured by employment and income growth.

Our work is closely related to the growing body of literature studying the effect of bank shocks on corporate innovation. Identifying the role of bank credit in financing innovation is not straightforward, but several studies have shown that firms decrease their level of innovation when exposed to local shocks in credit supply (Contreras et al., 2021; Kipar, 2011; Nanda and Nicholas, 2014; Spatareanu et al., 2019). For example, Nanda and Nicholas (2014) found that an increase in county-level bank distress, indicated by the number of bank suspensions, led to a decline in both the quantity and quality of patenting by firms during the Great Depression. Contreras et al. (2021) used firm-level data and bank branch-level analysis to show that local bank failures significantly reduced both the number of patents and citations during the financial crisis period. Similar studies outside the U.S. have found comparable results. Spatareanu et al. (2019) found that bank distress during the financial crisis forced banks to cut loans to UK firms, leading to reduced innovation by those firms. Additionally, Kipar (2011) demonstrated through survey data of German firms that restricting bank lending increased the probability of discontinuing ongoing innovation activity during the crisis.

Although collaboration has become a dominant approach to organizing production in science and patenting (Kim, 2022; Toole et al., 2019), the impact of bank failures on team-based innovative activity remains largely unexplored in the existing literature. This paper addresses this gap by examining whether local bank shocks influence both team innovation

output and team-specific human capital. Our findings shed light on how firms reallocate resources across multiple team projects when faced with external credit constraints. Unlike previous studies, we do not limit our analysis to the Great Depression or the recent financial crisis because firms do not immediately change their patent decisions, considering the multi-year process of innovation. Furthermore, the economic uncertainty inherent to crises frequently compels firms to scale back innovation investments (Peia and Romelli, 2022). To mitigate concerns that our findings might be confounded by such crisis-induced uncertainty, we show that our results remain robust even when excluding the 2007–2009 financial crisis from the sample.

2.2. Team Dissolution and Productivity

This paper is closely related to two recent studies that shed light on team-specific human capital and productivity of team-dependent workers in innovation. First, Jaravel et al. (2018) investigate how an inventor's premature death, defined as deaths occurring before or at the age of 60, affects their co-inventor's earnings and innovation outputs following the death. Using Treasury administrative tax data and U.S. patent data from 1996 to 2012, they find that the loss of a co-inventor due to premature death results in a persistent decline in the earnings and citation-weighted patent output of surviving inventors. Their findings indicate that maintaining collaborative relationships with the same co-inventor enhances an inventor's career outcomes beyond co-inventions, as the survivor can no longer engage in additional co-inventions with their deceased co-inventor.

Second, Baghai et al. (2019) analyze the impact of corporate bankruptcy on team stability and the productivity of inventors who worked in teams at a bankrupt firm. By tracking the careers and productivity of inventors employed by U.S. publicly traded firms that filed for bankruptcy during the period from 1980 to 2010, they find that inventor teams tend

to break up around the time of bankruptcy. Inventors previously engaged in collaborative relationships produce fewer and less impactful patents following bankruptcy. In contrast, inventors who did not work in teams do not experience a decline in post-bankruptcy productivity. Additionally, they provide evidence that this negative impact is mitigated when team members with prior collaboration move together to a new firm post-bankruptcy, suggesting that full preservation of team stability through joint mobility enhances subsequent individual inventor productivity.

In summary, prior work on collaborative relationships among inventors suggests that accumulated team-specific human capital is largely built through past collaborative experience with the same co-inventor, highlighting the critical role of sustained partnerships in fostering future innovation. However, the research designs of these studies do not allow for the identification of which types of inventor teams are more vulnerable to external shocks for future co-invention within the same firm. This limitation arises because their analyses focus on scenarios where all inventor teams ultimately dissolve within the firm due to disruptive events, such as premature death or corporate bankruptcy.

Our study contributes to the literature by using local bank failures as an exogenous shock to disrupt some inventor teams, enabling us to examine the evolution of teamwork within firms in response to negative local credit shocks. This setting is particularly well-suited for exploring how firms allocate team-specific human capital across multiple projects, as it provides detailed insights into the patenting collaboration histories of inventors over time. To isolate the role of team-specific capital from the broader effects of bank failures on team persistence, we identify key factors influencing the continuation of co-authorships, including physical proximity between team members and team size.

3. Testable Hypotheses

3.1. Match versus Experience in Team-Specific Capital

Which type of team-specific capital enables inventor pairs to continue working together during bank failures? To study the heterogenous effects of bank failures on subsequent innovation at the inventor pair level, this paper suggests a set of team-specific capital factors associated with team stability: spatial proximity, past collaboration, gender, and team size. First, we propose the "match" view of team-specific capital, suggesting that the stability of teams is primarily driven by the spatial proximity between inventors. We then offer the "experience" view, which indicates that past collaboration strengthens the co-patenting relationship between inventors in subsequent periods.

The labor economics and team management literature provide two competing hypotheses about the sources of team-specific capital: the "match" and "experience" views. It is important to distinguish these factors since they have distinct implications for fostering stable teamwork. The "match" view suggests that inventors face search and execution costs when making collaboration decisions. Search costs are defined as the costs to find a "good match" among potential set of collaborators, whereas joint execution costs include the costs of in-person meetings, coordination, monitoring, and knowledge sharing between team members (Catalini, 2018). Under the "match" view, geographic proximity minimizes these costs, with team-specific capital derived from lower costs being indicative of high-quality team matching.

Conversely, the impact of physical distance between team members on the stability of teams remains unclear. On the one hand, closer proximity may enhance the persistence of teamwork because spatial proximity allows inventors pair up more easily with lower search costs, thereby preserving their co-authorships more cheaply. On the other hand, when inventors in a team are less geographically dispersed, the team may be more likely to be dissolved as it become easier for them to have more individual time to develop other collaborative

networks due to lower joint execution costs. To assess the role of team-specific capital in team persistence under the "match" view, we use geographic distance between inventors in a pair as a proxy for search and joint execution costs. Specifically, the variable *CLOSE* is defined as taking the value of one if the distance between two inventors is less than 30 miles.

A competing view is that strong teams are shaped not by closeness but by repeated interactions between team members. According to the "experience" view, team-specific capital accumulates over the course of collaboration, enhancing productivity and teamwork. The accumulation of shared work experience facilitates smoother communication, better coordination, and mutual understanding, which collectively boost the team's innovative output and productivity (Jaravel et al., 2018). Moreover, the unique and non-substitutable nature of collaborative dynamics in teams reduces the cost of future team formation. By leveraging established relationships and pre-existing team-specific human capital, firms and inventors avoid the significant costs associated with forming and training new teams. Consequently, under the "experience" view, teams with substantial accumulated team-specific capital are more likely to persist and collaborate on subsequent projects, as the productivity benefits and cost efficiencies outweigh the potential disruptions of forming new collaborations. To test the effect of accumulated team-specific capital on the stability of teams, we use the history of past collaboration as a measure of shared work experience. The variable *PAST* is assigned a value of one if a pair of inventors produced a patent in the preceding three years. Taken together, this can be summarized in the following hypothesis:

Hypothesis 1. Team dissolution increases as a result of the higher costs associated with resource reallocation following bank failures. However, some inventor pairs can continue generating follow-on inventions if their team-specific capital is tied to geographic proximity or has been strengthened through accumulated past collaboration.

3.2. Gender Differences in Collaborative Positioning

Gender diversity in collaboration is crucial for enhancing innovative outcomes (Tahmooresnejad and Turkina, 2022). Despite the increasing presence of women in inventorship (Toole et al., 2019), existing research highlights persistent gender disparities in innovation. Female inventors remain underrepresented in team-based innovation and face greater challenges in establishing collaborative relationships compared to their male counterparts. For instance, men tend to collaborate more with other male inventors, and female academic scientists are less likely to patent due to limited professional networks (Ding et al., 2006; Whittington, 2018). The gender gap in co-patenting relationships implies that team stability could be particularly vulnerable if a pair of inventors consists of a mix of male and female inventors or only female inventors because female inventors have weaker co-inventing ties relative to male inventors. To explore how the gender composition of a team affects the likelihood that inventor teams break up within a firm, we construct the variable *FEMALE*, which takes the value of one if a pair of inventors includes at least one female inventor. To summarize:

Hypothesis 2. Conditional on projects being developed, the likelihood of inventor pairs remaining together for joint projects in subsequent periods decreases following bank failures if the pair includes at least one female inventor.

3.3. Team Size

We further examine whether team size is a crucial predictor of the pairwise stability of teamwork. The number of inventors listed on a patent has been increasing over time, but patents with two or three inventors accounted for the largest share of patents in 2016 (Toole et al., 2019). In larger teams, an individual inventor's contribution to joint production tends

to be relatively smaller, potentially weakening co-patenting relationships between team members. Conversely, inventors in smaller teams, such as those with two or three members, may find it easier to maintain strong pairwise connections, increasing the likelihood of continued collaboration. To access the impact of team size on team stability, we construct the variable *SMALL*, which takes the value of one if a pair of inventors works together on a patent with two or three inventors. This leads to the following hypothesis:

Hypothesis 3. Small team size is positively related to the likelihood that inventor pairs maintain their collaborative relationships over time within a firm experiencing bank failures.

4. Data and Empirical Model

4.1. Measuring Bank Failures

To exploit the variations in branches of failed commercial banks, we use publicly available data from the Federal Deposit Insurance Corporation (FDIC)'s Failures and Assistance Transactions database from 2000 to 2012. A distinguishing property of the FDIC data is that it covers all banks, not just banks that were members of the Federal Reserve System (Nanda and Nicholas, 2014). The FDIC provides detailed information on the location of each bank branch and main office, as well as the date of bank failures. A bank failure is declared by the FDIC when the bank ceases to exist and operate, and the institution's charter is terminated.

A distinctive element of this study is the identification of local credit shocks at the Core-Based Statistical Area (CBSA) level, as defined by the U.S. Office of Management and Budget. This CBSA-based approach accounts for a firm's alternative or more diversified lending strategies. Prior research on bank lending relationships has shown that some firms switch banks or start borrowing from multiple banks instead of relying on a single bank

(Farinha and Santos, 2002). The presence of multiple lenders with a pivotal bank positively contributes to a firm's capability to innovate, especially for high-tech firms (Giannetti, 2012). More importantly, local lending and investment decisions are primarily shaped by social and economic integration rather than strict political boundaries (Wehrmüller, 2014). Unlike prior studies that typically analyze county-level bank failures (Ashcraft, 2005; Calomiris and Mason, 2003; Huang, 2008; Kandrac, 2014), this paper links the county of each bank branch to its CBSA region. The CBSA framework aggregates one or more counties into regions defined by economic and social connections, such as commuting patterns, providing a more comprehensive understanding of local credit shocks.

Our main measure of bank failure (*FAIL*) is a binary indicator that equals one if a firm is located in a CBSA region containing a branch of a failed bank and zero otherwise. This measure encompasses two scenarios: (1) the closure of a bank's main office, which has systemic repercussions across its entire branch network, and (2) the closure of a local branch, reflecting region-specific disruptions without the collapse of the entire institution. The (*FAIL*) indicator is designed to capture localized financial shocks that may constrain the availability of capital, thereby affecting the capacity of innovators in the region to secure the resources necessary for innovation development. Furthermore, to capture variations in the intensity of bank failures across regions, we construct a continuous measure of bank failure (*INTENSITY*), defined as the ratio of the total number of branches of failed banks to the total number of branches of all banks in a CBSA region and year, consistent with the approach used by Contreras et al. (2021).

Figure 1 shows the geographical distribution of the total number of branches of failed banks across CBSA regions in the U.S. The highest concentrations are found in major metropolitan areas and economic hubs, particularly in Southern California (Los Angeles area), South Florida (Miami-Fort Lauderdale-West Palm Beach area), the New York metropolitan area, and the Atlanta area in the Southeast. Other notable areas with high concentrations

include Dallas and Houston in Texas. In contrast, rural and less densely populated CBSA regions in the western and central U.S. show few or no failed bank branches.

[Insert Figure 1 here]

4.2. Measuring Team Stability

To construct a novel inventor pair-firm-year panel dataset for U.S. publicly traded firms, we combine three different data sources. First, the U.S. Patent and Trademark Office (USPTO) tracks all patents ultimately granted by the USPTO from 1976 onward, capturing the entire universe of inventors and their firms in the U.S. The dataset contains detailed information on granted patents, including application and grant dates, technology class categories, patent inventors' information, and the name and address of patent assignees. The USPTO PatentsView database generates a unique assignee ID using a disambiguation algorithm, which helps address concerns about different firm names. However, we do not have complete confidence that subsidiaries are identified under the unique assignee ID from PatentsView. To alleviate concerns about name or ownership changes, we merge PatentsView data with data from the Duke Innovation & Scientific Enterprises Research Network (DISCERN). DISCERN matches patents to Compustat firms over the period 1980-2015 to address two major challenges we addressed (Arora et al., 2021). We also obtain information on firm size, such as total asset, from the Compustat database. To better understand the U.S. bank-firm relationship, we exclude assignees that are either governments, universities, or individuals. As a result, our final sample covers the period 2000 to 2012 and consists of 508,729 pair of inventors-firm-year observations, representing 434,816 unique inventor pairs employed at 1,660 U.S.-listed public firms.

Most researchers use the filing or application date as a stand-in for the date of invention in empirical work involving patents. However, the application year is not an appropriate

time reference in this analysis because we are interested in whether inventors can rebuild their original team for the generation of follow-on inventions when access to external funding sources is limited due to bank failures. Since the application date depends on the completion of the innovation, it represents the end date of invention. Schmoch (2009) argues that patent analysis should be made with reference to the first year of application, i.e., priority year, to achieve an appropriate link to other innovation indicators. According to legal regulations, the actual timing of invention is closer to the priority date than to the application date because immediate protection is important to avoid severe restrictions as of the priority date. To better capture the onset of truly novel team innovation, we extract the priority date, which represents the start of a new project, distinguishing it from continuing applications that extend existing projects.[1] We then link each patent listed on inventor pairs to banking data to examine how the stability of co-authorships evolves during periods of bank failures.

The focus of this paper is the likelihood of inventor teams maintaining their co-authorships for subsequent joint projects in the aftermath of bank failures. To analyze co-inventorship dynamics, we track inventor teams from patent to patent over the course of their collaboration. The sample includes inventors who have at least one collaborator, with team sizes ranging from two to five inventors for simplicity. For patents with more than two inventors, we decompose the inventor teams into all possible pairs (e.g., a patent with four inventors generates six unique pairs for analysis). Each observation represents a pair of inventors collaborating on a patent with at least two inventors. To investigate the impact of U.S. banking shocks on team persistence, we exclude pairs involving international inventors. Consequently, the analysis focuses exclusively on U.S.-based inventor pairs working within teams.

Our main measure of team persistence ($PAIR_PERSIST$) is a dummy variable that equals one if a pair of inventors has a follow-on invention together within the next three years and

[1] We extract the earliest application date at the head of any string of continuing applications that lead to the patent as the invention or priority year. If the earliest application date was preceded by an application in a foreign jurisdiction, we use instead the foreign application (priority) date as the invention date.

zero otherwise. By following cumulative inventor profiles over time, a possible repeating pair is identified as follows: if inventors A and B collaborate on a patent in year T and are subsequently found on another patent within the same firm during the following three years, they are classified as a repeating pair.[2] When the same subsets of inventors repeatedly appear on multiple patents within a specified time window, we consider the team to be persistent. This analysis of team persistence captures the long-term nature of investments in innovation by reducing the influence of idiosyncratic shocks that might distort innovation outcomes in any single year. By focusing on the recurrence of inventor pairs over time, we provide a more robust measure of sustained collaboration.

4.3. Empirical Model

We conduct tests with firm-year level data to examine whether a firm tends to downsize team innovation when facing local bank failures. Our main measure of bank failure (*FAIL*) is a dummy variable that equals one if a firm is located in a CBSA region that has a branch of a failed bank and zero otherwise. We use the following OLS specification:

$$Innovation_{fst} = \beta FAIL_{fst} + \mu Y_{fct} + \gamma X_{ft} + \phi_{ft} + \epsilon_{fst} \tag{1}$$

where $Innovation_{fst}$ is one of dependent variables for team innovation: *ln (Team Patent)*, *Team Size*, and *ln (Unique Pair)*. To capture the quantity of team innovation output, the variable *ln (Team Patent)* is defined as the natural logarithm of one plus the total number of team patents generated by a firm f located in CBSA region s measured as of the invention year t. To further assess team innovation input, we construct two additional measures: *Team size*, measured as the average size of the inventor team, and *ln (Unique Pair)*, defined as the natural logarithm of one plus the total number of unique combinations of two inventors listed

[2]If a pair of inventors has multiple patents in year T, we use the earliest invention date in year T to measure team persistence.

on a patent. We expect β to be negative. The parameter ϕ_{ft} corresponds to firm-by-year fixed effect, which account for time-varying unobservable firm characteristics that may affect innovation. For firm size, X_{ft} is the natural logarithm of total assets of firms. Y_{fct} is the county-level unemployment rate to control for local economic conditions. Standard errors are clustered at the firm level to account for any correlation in error terms within firms. To minimize the effect of outliers, we winsorize firm size at the 1st and 99th percentiles of their empirical distributions.

Turning to inventor pair-level analysis, the focus of the analysis is the role of team-specific human capital in team stability during bank failures. Employing a probit model, we estimate the heterogeneity of the average marginal effect using the Eqs. (2) and (3) below:

$$PAIR_PERSIST_{ifst} = \delta FAIL_{fst} + \mu Y_{fct} + \phi_{ft} + \phi_i + \phi_j + \epsilon_{ifst} \tag{2}$$

$$PAIR_PERSIST_{ifst} = \delta FAIL_{fst} + \sum_i \zeta_i (Group_i \times FAIL_{fst}) + \mu Y_{fct} + \phi_{ft} + \phi_i + \phi_j + \epsilon_{ifst} \tag{3}$$

When estimating Eqs. (2) and (3), $PAIR_PERSIST_{ifst}$ is a measure of team stability across inventor pairs and over time. It takes the value of one if a pair of inventors i formed in year t produces follow-on patents within the subsequent three years in the same firm f. It represents continuity in teamwork as forward collaboration by subsequent patents.

To test for heterogeneity in the effect, we include interaction terms between $FAIL_{fst}$ and the variables $Group_i$ in Eq. (3). In Eq. (3), $Group_i$ are a set of subgroup indicators, and the estimated coefficients ζ_i capture the differential effects of the local bank failures in each sub-group. The sub-groups are defined by different types of team-specific capital: *CLOSE*, *PAST*, *FEMALE*, and *SMALL*. For each inventor pair i in year t, *CLOSE* takes the value of one if the geographic distance between the two inventors in the pair is less

than 30 miles and zero otherwise. As a measure of backward collaboration, *PAST* takes the value of one if a pair of inventors i in year t produced a patent within three years of their previous patents. It captures internalized team-specific capital through past patenting activities within the unique pair. To measure team composition by gender, *FEMALE* takes the value of one if a pair of inventors consists of at least one female inventor (female-only pairs or mixed-gender pairs) and zero otherwise. Lastly, *SMALL* takes the value of one if a pair of inventors works together on a patent with two or three inventors, and zero if their team size is relatively larger, such as teams of four or five inventors. The interaction terms between the dummy variable for bank failures and the set of team-specific capital variable capture whether the likelihood of team stability during bank failures is associated with a specific team characteristic. For example, if prior joint-patenting experiences ($PAST$) are an important factor for future co-invention during bank failures, then inventor pairs with past collaboration will be not dissolved within the firm. The regression includes the following control variables: ϕ_{ft} denotes firm-by-year fixed effects, which account for time-varying unobservable firm characteristics that may affect the stability of teams. ϕ_i denotes inventor pair fixed effects to control for time-invariant differences in inventor team characteristics that are unobservable to us. In addition, ϕ_j includes dummy variables for three types of organizations they are affiliated with: Wet, Dry, and Mix research labs. These attributes help capture potential factors related to the allocation of resources within a patent technological field. According to the World Intellectual Property Organization (WIPO) technological class reported on each patent, we match each patent to one of five WIPO macro-classes: Electrical Engineering, Instruments, Chemistry, Mechanical Engineering, and Others. We then distinguish wet labs from dry labs based on the representative technological class of patents that firms have during the study period. For instance, a firm is defined as a wet lab if the majority of its patents are in chemical fields. Conversely, a firm is considered a dry lab if most of its patents are in non-chemical fields. We define a firm as a mixed lab if approximately half of its patents are

in chemistry. The models also include county-year level unemployment rates to control for local labor market and economic conditions. Standard errors are clustered at the firm level to account for any potential correlation in error terms within firms. We report summary statistics of these variables in Table 1. A summary of the variable definitions is provided in the Appendix.

[Insert Table 1 here]

5. Results

5.1. The Effect of Bank Failures on Team Innovation by Firm Size

Before identifying the effect of bank failures on team persistence at the inventor pair level, it is useful to check whether firms tend to downsize during bank failures in terms of their team innovation. For example, a firm may be unable to undertake all ongoing team projects when it is difficult to obtain external funding due to bank failures. In such cases, the firm may need to cut riskier team projects to allocate resources more efficiently, which in turn limits the number of team-based patents and dissolves some inventor teams. To shed light on different aspects of team innovation at the firm level, we use patents listed on multiple inventors employed by a firm and construct three measures of team innovation: *ln (Team Patent)*, *Team Size*, and *ln (Unique Pair)*.

The effect of bank failures on team innovation may differ by firm size. Large innovative firms may be more adversely affected because they have more R&D projects with large team sizes that require dynamic connections between inventors. Table 2 presents our results by splitting our sample based on firm size. Column 1 reports the coefficients from a regression specification without controls for firm size, while Column 2 includes controls for firm size. In the second Column, we find that exposure to bank failures reduces the number of team

patents by 5.8 percentage points and inventor pairs by 5.1 percentage points. This implies that the incidence of branch closings has a greater effect on team-based patenting outcomes than on the stock of team-specific human capital. This finding suggests an interesting angle that local financial shocks may disrupt team production (the "blades of grass") but leave the underlying team-specific capital (the "roots") intact. Conversely, we do not observe evidence that bank failures lead to a reduction in team size. A potential explanation for this stability is that altering the average team size or restructuring team composition may impose additional adjustment costs or risks, particularly during periods of credit shocks. To minimize these uncertainties and associated costs, firms are likely to maintain a stable team size even in the face of financial disruptions. Figure 2 presents the estimated coefficient from the second Column of the same table.

In addition, we find that the detrimental effect of bank failures on team patents and the loss of team-specific capital are larger for large firms than for small firms. This finding aligns with the perspective that large firms tend to scale back their innovation activities in response to bank failures (Contreras et al., 2021).

[Insert Table 2 here]

[Insert Figure 2 here]

5.2. Geographic versus Social Proximity in Team Persistence

We now focus on the effect of bank failures on pairwise team persistence. To study the role of team-specific capital in the stability of teams in the event of bank failures, we decompose the effects of bank failures on persistence in collaboration by the "match" and "experience" views described in Section 3.1. Switching from firm-level to inventor pair-level analysis, we provide direct evidence in support of both the "match" and "experience" views (Table 3). While Column 1 shows no significant effect on team persistence on average,

Column 2 highlights that geographic proximity and prior collaboration experience are key factors in maintaining team stability under bank shocks. Among these, prior collaboration experience is the most critical factor in preserving co-authorships during periods of financial constraints. This finding suggests that firms take a more conservative approach to team formation and project allocation during local credit constraints, relying heavily on established team dynamics to reduce risk.

The main implication of the "match" view is that closer proximity could be more crucial for skilled workers because it enables more interpersonal communication and collaboration, thereby enhancing subsequent joint work (Catalini, 2018). Consistently, Baghai et al. (2019) highlight the benefits of co-location and provide supporting evidence that the post-bankruptcy productivity of inventors who jointly move to a new firm with their team members increases relative to inventors whose teams are permanently broken up due to bankruptcy. In line with the predictions from the "match" view of team-specific capital, the estimated coefficient in the interaction term shows that the likelihood of a pair of inventors producing follow-on patents during bank failures increased by 4.7 percentage points when they are tied to geographic boundaries (Column 2). This implies that a pair of inventors is well-matched with physical proximity, which drives new opportunities to cumulative innovation by preserving co-authorships more cheaply.

We also find supporting evidence that stable co-authorships are developed through social proximity (e.g., prior joint-patenting experiences) over the course of collaboration. This results from the "experience" component, which decreases the risk of invention output and uncertainty about teamwork over time. For instance, as two inventors learn how to best collaborate with each other through several joint projects, they become more capable of innovating and building on new technologies together in subsequent periods. According to the "experience" view, our results show that inventor pairs with past collaboration are more likely to preserve their invention relationships following bank shocks. This implies

that relationship-specific investments play a significant role in the generation of follow-on patents. This finding is consistent with the idea that accumulated team-specific human capital, characterized by a history of collaboration at the unique pair level, strengthens collaborative relationships by increasing trust between inventors or reducing moral hazard (Jaravel et al., 2018).

Another important result in Column 2 is that bank failures significantly decrease the likelihood that inventor pairs remain together. This indicates the detrimental effect of bank failures on team stability for inventor pairs without team-specific capital. As we discussed earlier, geographic proximity and past collaboration buffer the detrimental effects of bank failures on the stability of teams. Taken together, our results suggest that the impact of bank failures on team persistence varies across types of human capital embedded in teams, highlighting the crucial role of team-specific capital in collaborative relationships. Figure 3 shows the estimated coefficients in Column 2 as the baseline results: when faced with a more heterogenous set of team projects, social proximity plays a more critical role in preserving teamwork, as past collaboration has a larger effect on the likelihood of team persistence compared to the magnitude of geographic proximity.

In Column 3 of the same table, we show results from a model that includes only two interaction terms: spatial proximity and past collaboration with bank failures. The findings from this pared-down model help clarify the interpretation of these interaction effects by providing a comparison between two distinct types of team-specific capital. From Column 3, we see that, holding other factors constant, team persistence is more closely tied to prior joint-patenting experiences relative to spatial proximity. This suggests that accumulated team-specific capital through past collaboration may have served as a powerful trigger for inventor pairs to remain together for projects in subsequent periods during bank failures.

5.3. Gender Disparities in Team Persistence

Women are increasingly participating in large, gender-mixed inventor teams (Toole et al., 2019). Despite their growing contributions to co-inventing activities, men often develop collaborative networks predominantly with other men (Whittington, 2018). Given these gender disparities in collaboration, we examine whether the continuity of teamwork is influenced by gender when access to external funding is constrained.

The results reveal a negative coefficient for the interaction term *FEMALE*FAIL*, reported in Column 2 of Table 3, indicating that inventor pairs including at least one female are less likely to persist during bank failures. However, this effect is not statistically significant, suggesting that the inclusion of a female inventor does not significantly help teams maintain collaboration during credit supply shocks. These findings imply that gender-related team structures are not strongly associated with the likelihood of continued collaboration following initial involvement. Furthermore, the results may reflect the tendency of women to collaborate repeatedly with the same partners, which fosters stable teamwork over time (Ductor et al., 2023), though this does not necessarily translate into an advantage under financial constraints.

In Columns 4-6 of the same table, we show the differential effects of branch closing on team persistence by gender composition. We find a similar pattern of team stability during bank failures: past collaboration is largely associated with stable teamwork in all inventor pairs, but the magnitudes differ substantially across sub-groups. Column 4 reports that the role of past collaboration in team stability is larger for male inventor pairs during bank failures, while Columns 5 and 6 indicate that the effect of spatial proximity is larger in female or mixed-gender pairs.

5.4. Team Size

The size of a team is an important aspect of patenting activity (Peltokorpi and Hasu, 2014). To shed light on the effect of team size on sustaining co-authorships during bank failures, we divide the sample into two groups based on team size. We construct a dummy variable *SMALL* as a proxy for small team size, where it equals one if a pair of inventors work together on a patent with two or three inventors. In Column 2 of Table 3, we find that small team size is positively associated with the stability of teams during periods of bank failures. This result supports our hypothesis that pairwise connections between team members are stronger when team size is small, which enables them to retain their co-authorship for generating follow-on inventions in subsequent periods.

[Insert Table 3 here]

[Insert Figure 3 here]

6. Robustness Checks

6.1. Using Out-of-Region Headquartered Banks

To address the possible concern that our measure of bank failures captures unobservable local conditions that could be correlated to our main variable of interest, we repeat the analysis of Table 3 in a subsample of firms with little exposure to local economic conditions. For instance, poor local economic conditions could not only impede co-invention activities but also trigger a bank run, resulting in the failure of bank headquarters in that area. However, a region-specific factor that endogenously correlates with the health of the bank headquarters should not lead to the failure of an out-of-region headquartered bank (Contreras et al., 2021). In Column 1 of Table 4, we show that the results are robust to further restricting the sample to firms that are only exposed to branch closings due to the failure of bank headquartered

in another region. This implies that the incidence of branch closings is plausibly exogenous to local economic conditions. The consistency of the signs suggests that any endogenous concerns stemming from unobservable local economic conditions are unlikely to be an issue in this analysis.

6.2. Excluding California

In our sample, more than one-third of patents are produced in California. To ensure that inventor teams employed by firms in that state do not drive our results, we exclude California from the sample and present the results in Table 4. Consistent with our baseline results, Column 2 reports that exposure to bank failures is associated with a reduced likelihood of team stability. However, spatial proximity, past collaboration, and small team size increase the likelihood that inventor pairs collaborate more with the same collaborator at the same firm when their firm is exposed to negative banking shocks.

6.3. Excluding the Crisis Years

A remaining concern is that the effect of bank failures on team stability could result from the inherent economic uncertainty during the recent financial crisis. The number of branches of failed bank dramatically increases in times of crisis (Contreras et al., 2021), and credit market disruptions during the crisis constrain a firm's ability to invest in the development and introduction of new products (Granja and Moreira, 2023; Peia and Romelli, 2022; Spatareanu et al., 2019). This implies that repeated collaboration of inventors could be more threatened during the crisis. To alleviate this concern, we show in Column 3 of Table 4 that the results are robust to excluding the crisis years of 2007-2009, similar to Cornaggia et al. (2015).

6.4. Excluding Unknown Gender Teams

As shown in Table 1, almost 16% of the sample consists of inventor pairs with unknown gender. To improve the power of our estimates, we repeat the analysis by excluding unknown gender pairs from our sample. The results in Column 4 of Table 4 show a similar pattern to those in Table 3. Figure 4 illustrates a series of robustness checks discussed above that support our mainline results.

[Insert Table 4 here]

[Insert Figure 4 here]

6.5. Alternative Time Windows of Team Stability

To show that our results are not sensitive to alternative specifications of our main variable of interest, we further implement robustness tests using a two-year window ($PAIR_PERSIST_2YR$) or a four-year window ($PAIR_PERSIST_4YR$) instead of three years for team stability. Our main measure of team stability ($PAIR_PERSIST$) is a dummy variable that takes the value of one if a pair of inventors produces follow-on invention within the next three years and zero otherwise. This measure is predictive of the speed at which inventor pairs are jointly able to generate follow-on innovation at the same firm. However, it is unclear what the optimal speed of follow-on innovation is that best describes team persistence. Using tight or more generous windows of follow-on invention, Table 5 shows that our results are robust to these alternative time windows of team stability. Figure 4 displays the estimated coefficients in Table 5, suggesting that the results are consistent with our main finding using the original measure of team stability.

[Insert Table 5 here]

[Insert Figure 5 here]

6.6. Impact of the Intensity of Bank Failures on Team Persistence

This section expands the analysis by examining how the intensity of bank failures, which is closely tied to poor local economic conditions, impacts team persistence. While both this section and Section 6.1 address potential endogeneity concerns related to poor local economic conditions, their approaches differ. Section 6.1 focuses on isolating exogenous bank shocks caused by out-of-region headquartered bank failures to mitigate endogeneity concerns. In contrast, this section investigates how the magnitude of regional financial disruptions influences the persistence of collaborative innovation, with particular attention to potential spillover effects. Spillover effects occur when the closure of multiple bank branches within a region disrupts not only the firms directly associated with the failed banks but also the broader financial ecosystem. These disruptions can amplify regional credit constraints, indirectly undermining firms' ability to maintain collaborative inventor teams and sustain innovation activities over time.

The intensity of bank failures is measured using a continuous measure ($INTENSITY$), defined as the ratio of failed bank branches to total bank branches within a CBSA region. This measure allows us to evaluate how varying levels of banking disruptions affect the stability of inventor teams, providing a deeper understanding of the broader impacts of financial instability on their long-term persistence.

The results, presented in Table 6, indicate that the intensity of bank failures significantly reduces the likelihood of team persistence. Specifically, a 10-percentage-point increase in failure intensity corresponds to a 4.42-percentage-point decrease in the probability of team persistence. This finding suggests that the cumulative impact of multiple branch closures extends beyond immediate credit shocks, creating broader challenges for regional collaboration and innovation.

Columns 2-5 report that such effects are weakened when local credit markets are more

severely disrupted, suggesting that higher costs of labor adjustment due to limited labor mobility during periods of high bank failures force firms to retain inventors, which in turn reduces the probability of discontinuing teamwork. We also find that a higher magnitude of bank failures significantly lessens the positive impact of team-specific capital, such as spatial proximity or past collaboration, on team stability. Figure 6, which shows the estimated coefficients in Table 6, highlights that the gap between heterogeneity in the effect and the overall effect without team-specific capital shrinks with the greater severity of bank failures while past collaboration, spatial proximity, and small team size still play an important role in preserving co-authorships.

[Insert Table 6 here]

[Insert Figure 6 here]

7. Conclusion

This paper examines the consequences of credit shocks, particularly local bank failures, on team innovation and the mechanisms through which team-specific human capital supports sustained collaboration during such shocks. Using U.S. patent records and FDIC data on commercial bank failures, we provide several findings. First, firms exposed to local bank failures experience declines in team innovation, reflected in both the reduction of team patents and a lower number of collaborating inventor pairs. Second, negative banking shocks disrupt the continuity of inventor collaborations, reducing the likelihood of repeated co-invention within firms. Importantly, geographic proximity, prior collaboration, and small team sizes are identified as factors that mitigate these disruptions, underscoring their importance in preserving team stability. Finally, the absence of significant gender-based disparities suggests that team composition by gender does not determine the persistence of collaborative innovation during credit constraints.

We conclude by proposing some future research directions. First, a natural extension of this research would involve examining the career paths of inventors following team breakdowns to better understand the implications of disrupted collaboration. Key questions include whether team breakups are associated with a decline in collaboration quality and whether affected inventors tend to leave the firm (e.g., through layoffs) or are reassigned to new teams. Investigating these dynamics would enhance our understanding of how firms manage and reallocate human capital during periods of credit supply shocks.

Second, another important area for future research is the long-term impact of losing team continuity on innovation at both the firm and state levels. Building on existing literature on finance and innovation, such as the work of Contreras et al. (2021), Cornaggia et al. (2015), and Nanda and Nicholas (2014), future work could investigate how the loss of team-specific capital affects innovation outputs or quality over time.

Third, it would be valuable to investigate the stability of teams in the context of remote work feasibility. Although remote work was not common during our study periods, the findings of this study can be applied to derive implications for future research on collaboration and remote work. The COVID-19 pandemic of 2020, along with credit freezes and tremendous economic uncertainty, caused a dramatic change in work environments and forced firms and skilled workers to rapidly shift to working from home. While we offer suggestive evidence that inventor pairs with spatial proximity are more likely to continue their innovation activities together during bank failures under the "match" view, a transition to remote work can weaken the role of physical proximity in team stability by allowing more distant employees to work together through video conferencing and other virtual communication technologies. A remote work environment can further provide inventors with outside opportunities to expand their collaborative relationships with other inventors without restrictions on firm or geographic boundaries. Future research should explore the team stability of inventors experienced in remote collaboration.

Lastly, more attention to the role of gender in stable co-authorship is needed. One of our main findings indicates that gender-related team structure alone is not associated with the likelihood of continuing innovative activities during bank failures. In contrast, factors such as physical proximity, past collaboration, and team size significantly increase the probability of follow-on inventions with the same co-inventor. Building on the extensive literature on gender disparities in patenting (e.g., Ding et al., 2006; Rosser, 2009; Sugimoto et al., 2015), future research should explore the specific mechanisms influencing female inventors' ability to establish and maintain stable collaborative positions in team innovation. Understanding these dynamics could provide important insights into promoting gender equity in innovation ecosystems.

References

Anari, A., J. Kolari, and J. Mason (2005) "Bank asset liquidation and the propagation of the US Great Depression," *Journal of Money, Credit and Banking*, 37 (4), 753–773.

Arora, A., S. Belenzon, K. Kosenko, J. Suh, and Y. Yafeh (2021) "The rise of scientific research in corporate America,"Technical Report w29260, National Bureau of Economic Research.

Ashcraft, A.B. (2005) "Are banks really special? New evidence from the FDIC-induced failure of healthy banks," *American Economic Review*, 95 (5), 1712–1730.

Baghai, R., R. Silva, and L. Ye (2019) "Teams and bankruptcy,"Technical Report 17-19, Swedish House of Finance Research Paper.

Bernanke, B.S. (1983) "Non-monetary effects of the financial crisis in the propagation of the Great Depression,"Technical Report w1054, National Bureau of Economic Research.

Calomiris, C.W. and J.R. Mason (2003) "Consequences of bank distress during the Great Depression," *American Economic Review*, 93 (3), 937–947.

Catalini, C. (2018) "Microgeography and the direction of inventive activity," *Management Science*, 64 (9), 4348–4364.

Contreras, S., A. Ghosh, and J.H. Kong (2021) "Financial crisis, Bank failures and corporate innovation," *Journal of Banking Finance*, 129, 106161.

Cornaggia, J., Y. Mao, X. Tian, and B. Wolfe (2015) "Does banking competition affect innovation?" *Journal of Financial Economics*, 115 (1), 189–209.

De Dreu, C.K. (2006) "When too little or too much hurts: Evidence for a curvilinear relationship between task conflict and innovation in teams," *Journal of Management*, 32 (1), 83–107.

Ding, W.W., F. Murray, and T.E. Stuart (2006) "Gender differences in patenting in the academic life sciences," *Science*, 313 (5787), 665–667.

Ductor, L., S. Goyal, and A. Prummer (2023) "Gender and collaboration," *Review of Economics and Statistics*, 105 (6), 1366–1378.

Farinha, L.A. and J.A. Santos (2002) "Switching from single to multiple bank lending relationships: Determinants and implications," *Journal of Financial Intermediation*, 11 (2), 124–151.

Fay, D., C. Borrill, Z. Amir, R. Haward, and M.A. West (2006) "Getting the most out of multidisciplinary teams: A multi-sample study of team innovation in health care," *Journal of Occupational and Organizational Psychology*, 79 (4), 553–567.

Ghosh, A. (2017) "Do bank failures still matter in affecting regional economic activity?" *Journal of Economics and Business*, 90, 1–16.

Giannetti, C. (2012) "Relationship lending and firm innovativeness," *Journal of Empirical Finance*, 19 (5), 762–781.

Granja, J. and S. Moreira (2023) "Product innovation and credit market disruptions," *The Review of Financial Studies*, 36 (5), 1930–1969.

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

Jaravel, X., N. Petkova, and A. Bell (2018) "Team-specific capital and innovation," *American Economic Review*, 108 (4-5), 1034–1073.

Kandrac, J. (2014) "Bank failure, relationship lending, and local economic performance," *American Economic Journal: Macroeconomics*, 5 (1), 81–101.

Kim, J. (2022) "Teamwork in innovation under time pressure," *Labour Economics*, 75, 102137.

Kipar, S. (2011) "The effect of restrictive bank lending on innovation: Evidence from a financial crisis,"Technical Report 109, Ifo Working Paper.

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

Peia, O. and D. Romelli (2022) "Did financial frictions stifle RD investment in Europe during the Great Recession?" *Journal of International Money and Finance*, 120, 102263.

Peltokorpi, V. and M. Hasu (2014) "How participative safety matters more in team innovation as team size increases," *Journal of Business and Psychology*, 29, 37–45.

Rosser, S.V. (2009) "The gender gap in patenting: Is technology transfer a feminist issue?" *NWSA Journal*, 65–84.

Schmoch, U. (2009) "Patent analyses in the changed legal regime of the US Patent Law since 2001," *World Patent Information*, 31 (4), 299–303.

Spatareanu, M., V. Manole, and A. Kabiri (2019) "Do bank liquidity shocks hamper firms' innovation?" *International Journal of Industrial Organization*, 67, 102520.

Sugimoto, C.R., C. Ni, J.D. West, and V. Larivière (2015) "The academic advantage: Gender disparities in patenting," *PloS one*, 10 (5), e0128000.

Tahmooresnejad, L. and E. Turkina (2022) "Female inventors over time: Factors affecting female inventors' innovation performance," *Journal of Informetrics*, 16 (1), 101256.

Toole, A., M.J. Saksena, C.A. Degrazia, K.P. Black, F. Lissoni, E. Miguelez, and G. Tarasconi (2019) "Progress and potential: A profile of women inventors on U.S. patents,"Technical report, US Patent and Trademark Office.

Wehrmüller, S. (2014) "Bank lending and personal income in the Great Recession," *Journal of Money, Credit and Banking*, 46, 1239–1275.

Whittington, K.B. (2018) "A tie is a tie? Gender and network positioning in life science inventor collaboration," *Research Policy*, 47 (2), 511–526.

Ziebarth, N.L. (2013) "Identifying the effects of bank failures from a natural experiment in Mississippi during the Great Depression," *American Economic Journal: Macroeconomics*, 5 (1), 81–101.

Figures and Tables

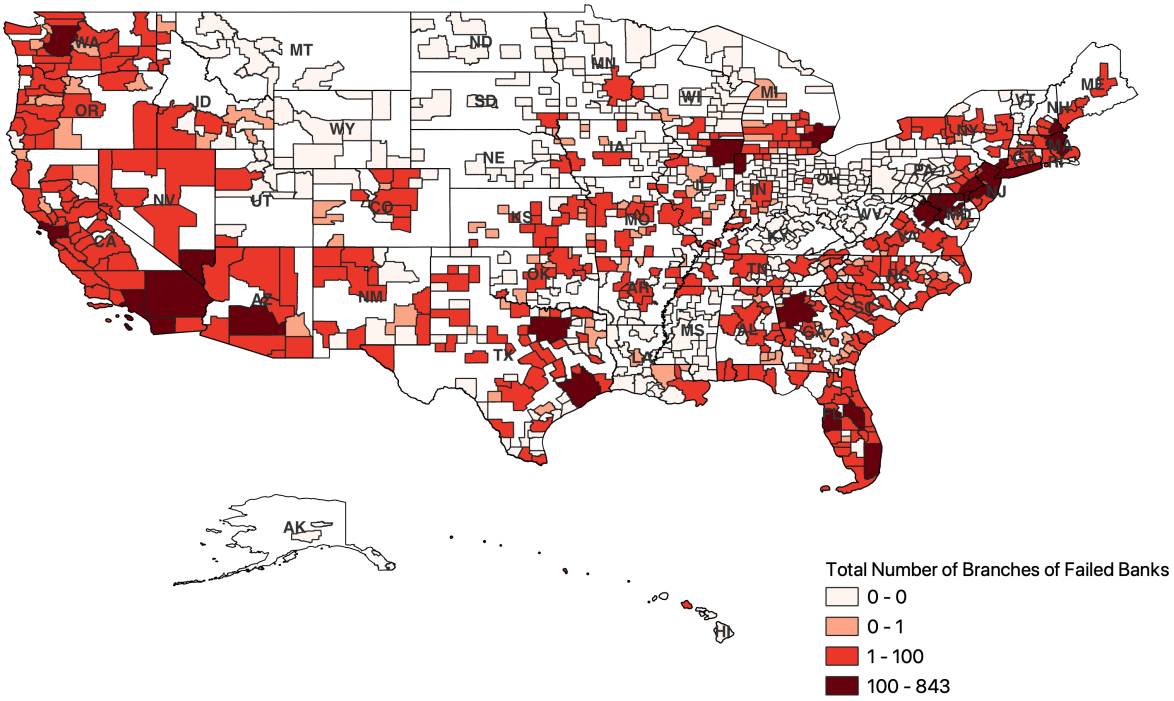


Figure 1: Geographical Distribution of Failed Bank Branches in U.S. CBSA Regions

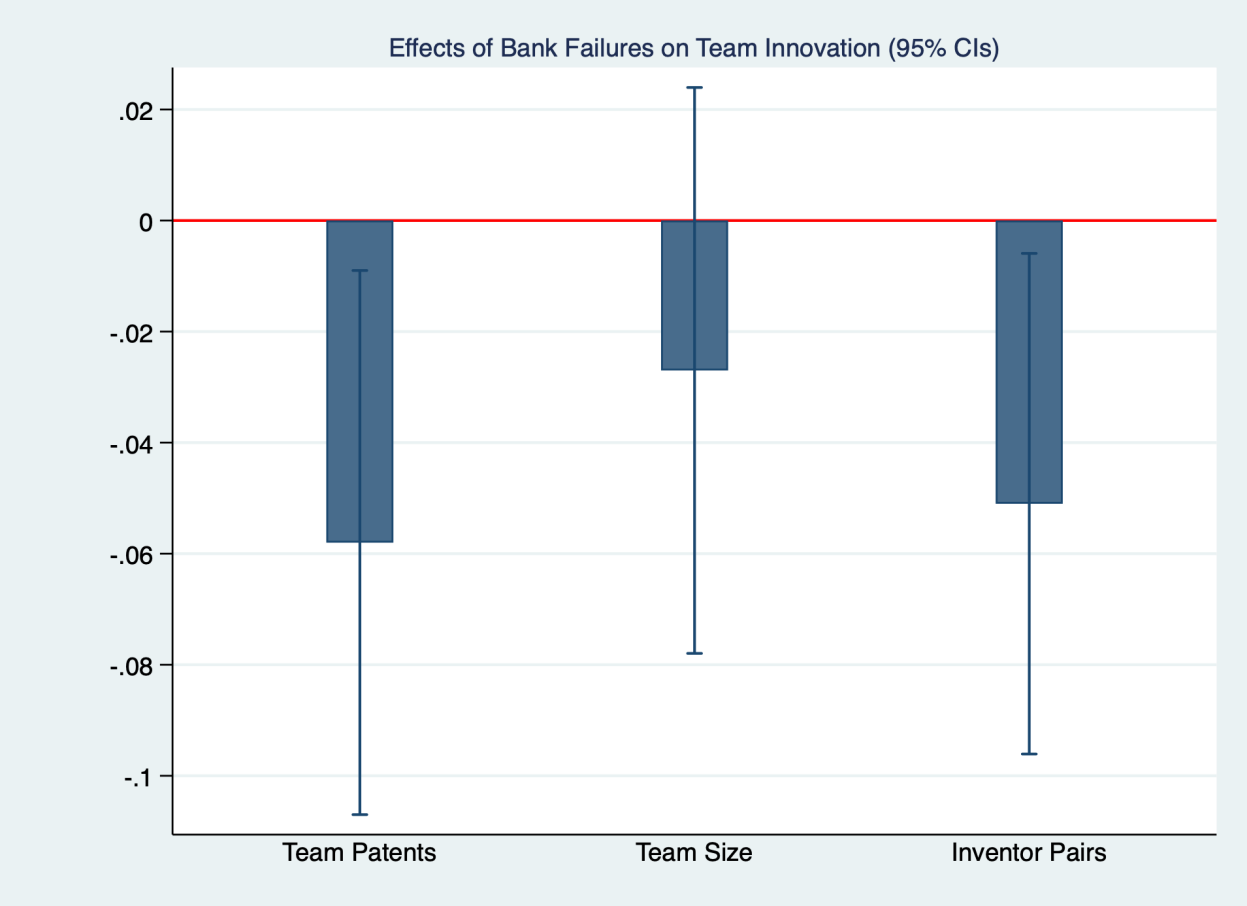


Figure 2: The Effect of Bank Failures on Team Innovation

Note: This figure displays the estimated coefficients from Column 2 of Table 2. Capped lines indicate the 95% of confidence intervals (CI) for the estimated coefficients.

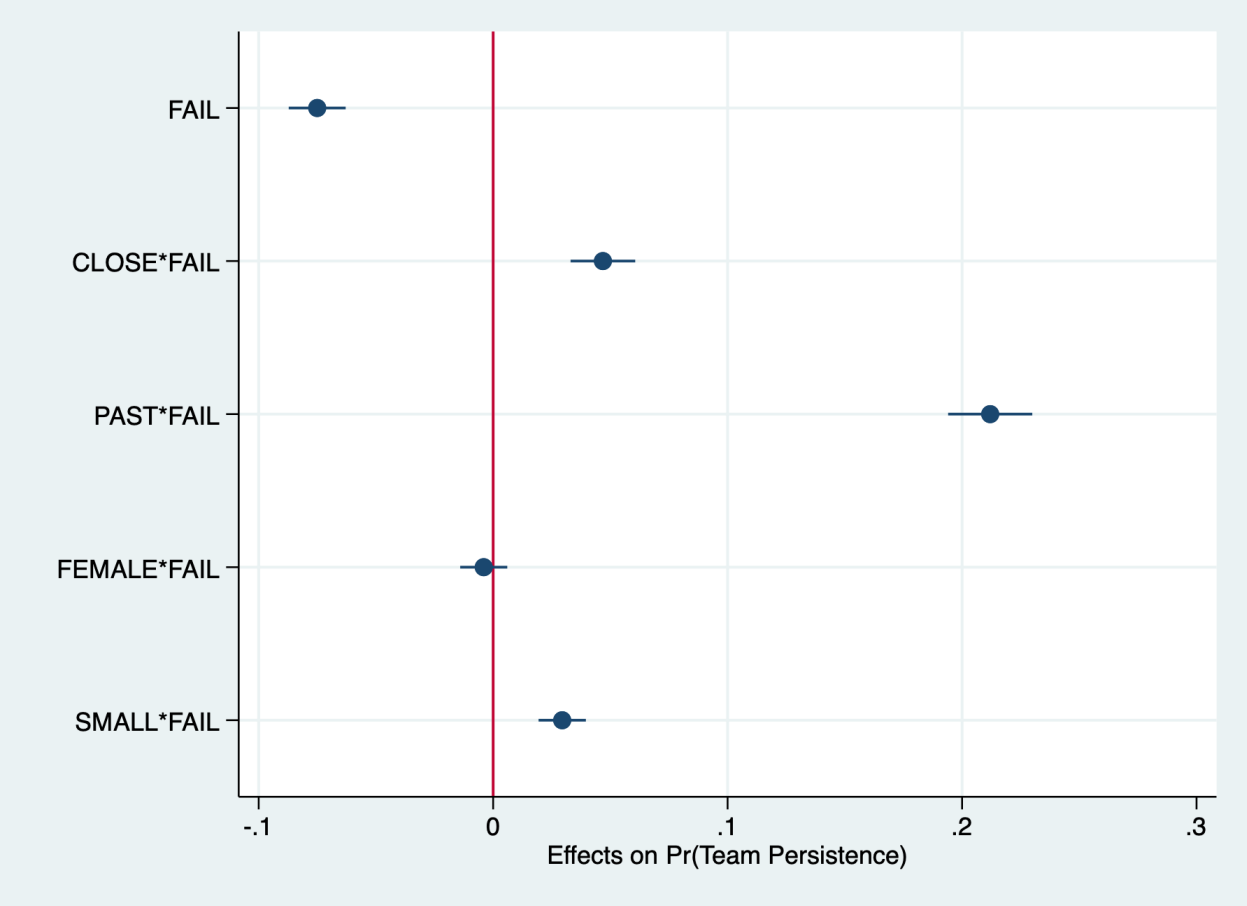


Figure 3: The Effect of Bank Failures on Team Persistence

Note: This figure displays the estimated coefficients from Column 2 of Table 3. Capped lines indicate the 95% of confidence intervals (CI) for the estimated coefficients.

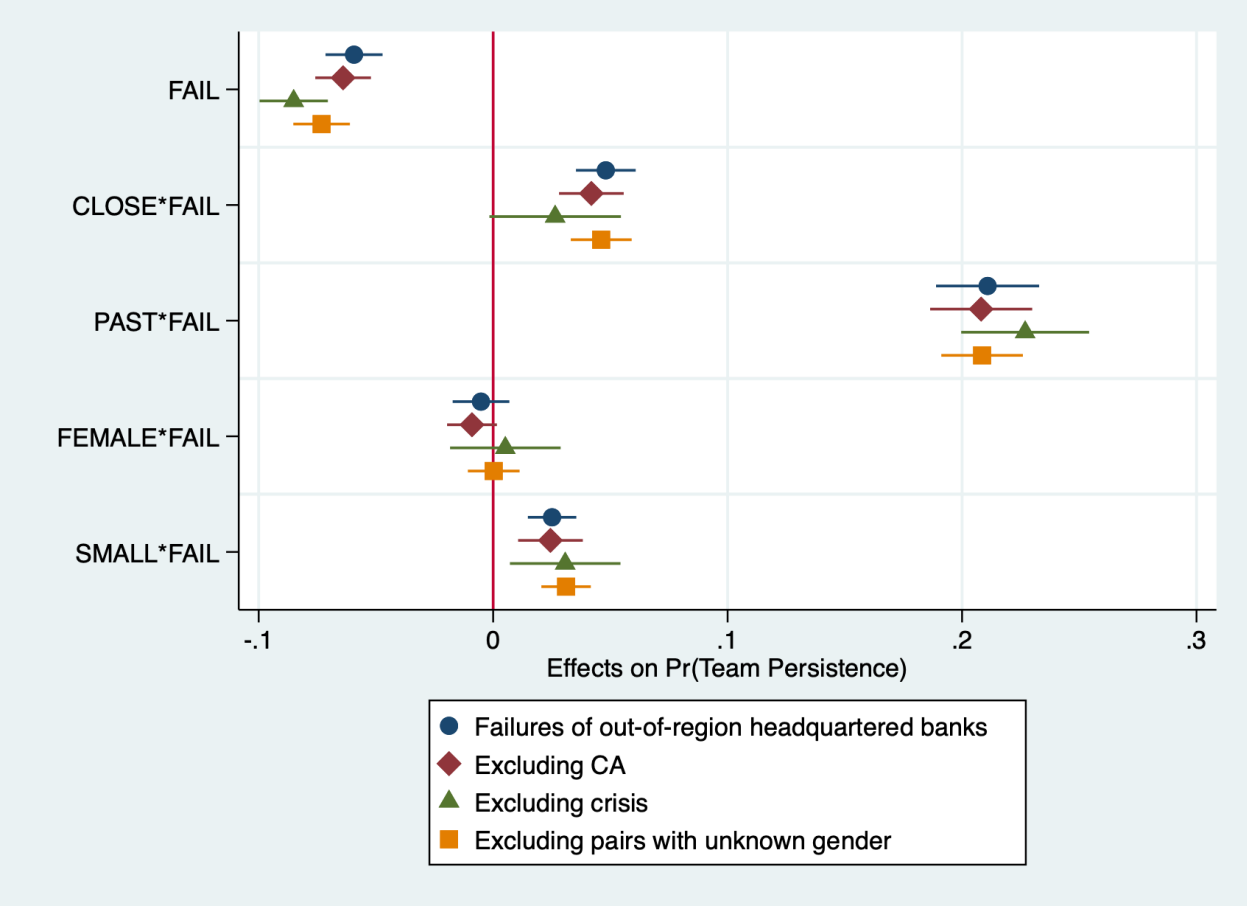


Figure 4: Robustness Checks on Team Persistence

Note: This figure displays the estimated coefficients from Table 4. Capped lines indicate the 95% of CI for the estimated coefficients.

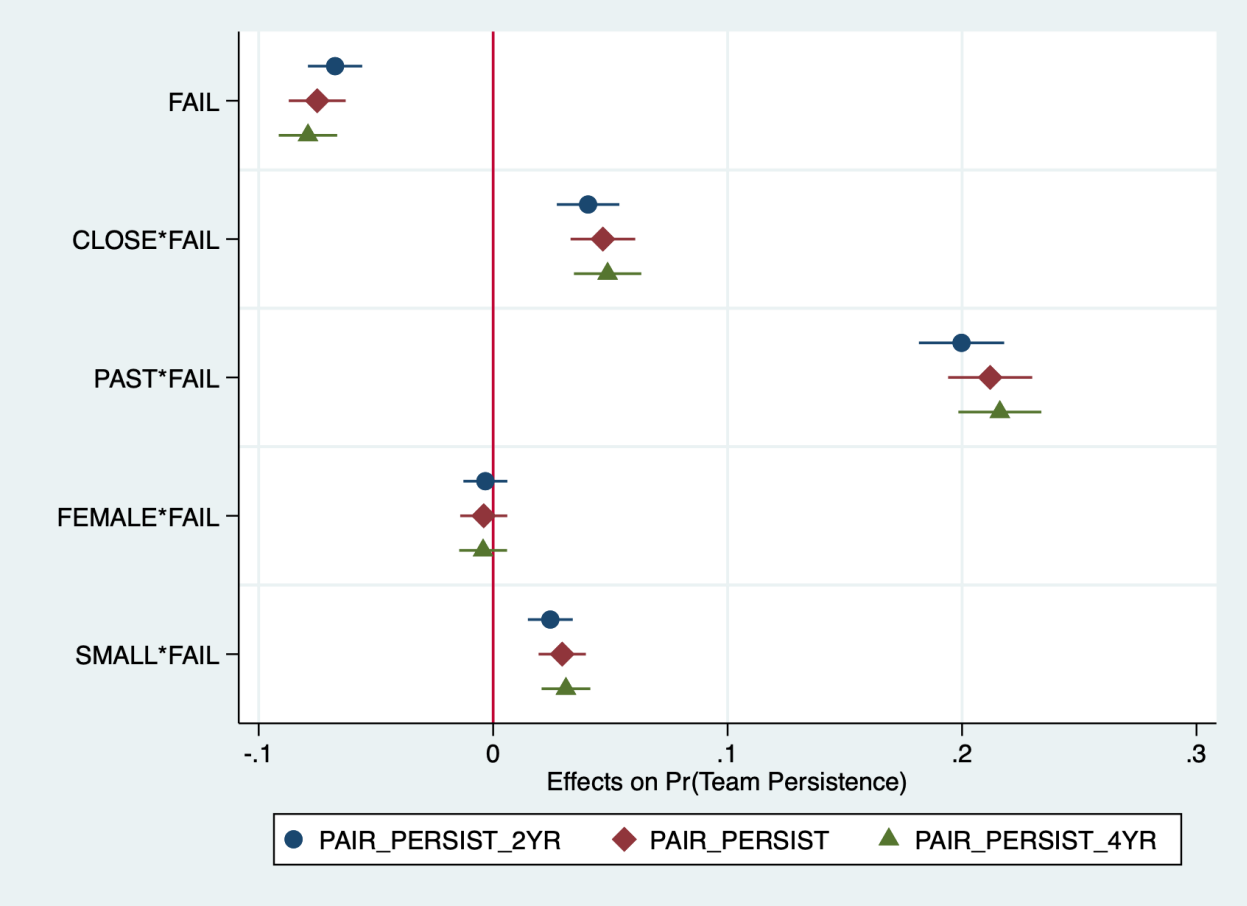


Figure 5: Results using Alternative Time Windows of Team Persistence

Note: This figure displays the estimated coefficients from Tables 3 and 5. Capped lines indicate the 95% of CI for the estimated coefficients.

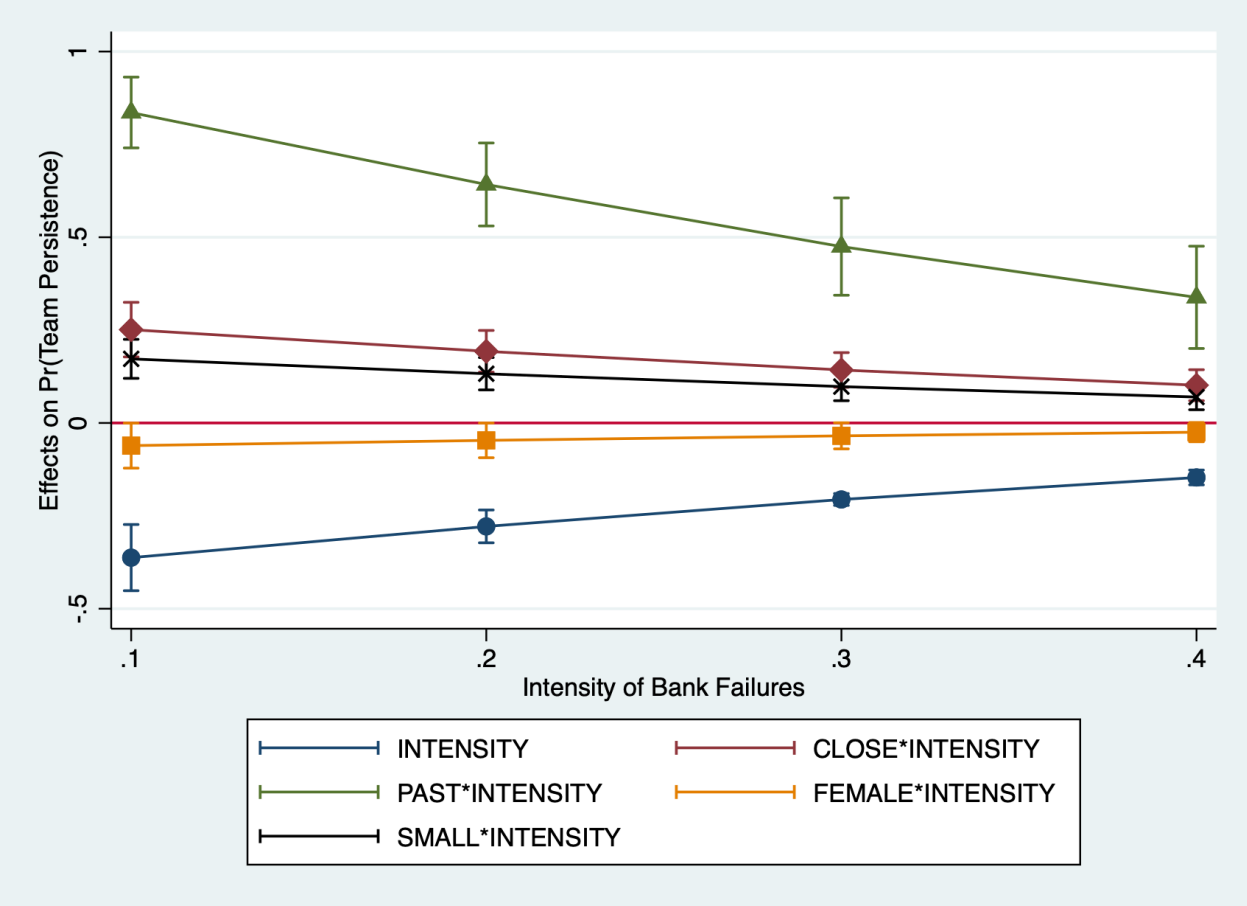


Figure 6: Differential Effects of the Intensity of Bank Failures on Team Persistence

Note: This figure displays the estimated coefficients from Table 6. Capped lines indicate the 95% of CI for the estimated coefficients.

Table 1: Descriptive Statistics

	N	Mean	SD	Min	Max
Panel A: Patent					
Invention year	165,531	2005.423	3.618	2000	2012
Filing year	165,531	2005.666	3.665	2000	2015
Grant year	165,531	2009.202	3.941	2000	2015
Team size	165,531	3.030	0.995	2	5
Patents in chemistry	165,531	0.124	0.330	0	1
Panel B: Inventor pairs					
US inventor pair	434,816	1.000	0.000	1	1
Distance between inventors (miles)	434,816	190.696	514.362	0	5,090
CLOSE (miles<30)	434,816	0.737	0.440	0	1
Male team	434,816	0.670	0.470	0	1
Female team	434,816	0.014	0.119	0	1
Mixed-gender team	434,816	0.152	0.359	0	1
Unknown gender team	434,816	0.163	0.369	0	1
PAIR_PERSIST	434,816	0.111	0.314	0	1
Panel C: Firm-Year observations					
Number of patents	12,212	13.561	50.201	1	1,242
Number of pairs	12,212	41.658	158.902	1	4,484
Assets (MIL, $)	12,212	8,902.020	19,016.239	0.048	242,223
SIZE (ln(Assets))	12,212	7.277	2.169	-3.037	12.398
FAIL	12,212	0.160	0.367	0	1
INTENSITY	12,212	0.012	0.042	0	0.364
Panel D: County-Year observations					
Unemployment rate	3,350	5.903	2.351	1	18

Note: This table reports summary statistics for patents, inventor pairs, firm-year observations, and various other variables used in the analysis, covering the period from 2000 to 2012.

Table 2: The Effect of Bank Failures on Team Innovation by Firm Size

	(1) All	(2) All	(3) Small	(4) Large
Panel A: ln (Team Patent)				
FAIL	-0.048*	-0.058**	0.013	-0.081**
	(0.025)	(0.025)	(0.032)	(0.032)
Constant	1.902***	0.294	0.285*	-0.076
	(0.067)	(0.206)	(0.149)	(0.381)
Adjusted R-squared	0.02	0.046	0.051	0.048
Panel B: Team Size				
FAIL	-0.026	-0.027	-0.083	-0.009
	(0.026)	(0.026)	(0.061)	(0.028)
Constant	2.871***	2.7***	2.761***	2.811***
	(0.054)	(0.154)	(0.206)	(0.205)
Adjusted R-squared	0.002	0.002	0.002	0.002
Panel C: ln (Unique Pair)				
FAIL	-0.041*	-0.051**	0.02	-0.073**
	(0.024)	(0.023)	(0.03)	(0.030)
Constant	1.841***	0.316	0.264*	-0.014
	(0.064)	(0.195)	(0.141)	(0.36)
Adjusted R-squared	0.02	0.045	0.05	0.049
Observations	12,748	12,748	4,729	8,019
County-level controls	Y	Y	Y	Y
Firm-Year FE	Y	Y	Y	Y
SIZE (ln(asset))	N	Y	Y	Y

Note: This table presents OLS regression estimates of Eq. (1). Observations are at the firm-year level from 2000-2012. The dependent variables include the natural logarithm of one plus the total number of team patents (*ln (Team Patent)*), average team size (*Team Size*), and the natural logarithm of one plus the total number of unique inventor pairs (*ln (Unique Pair)*). The results are split by firm size, using firm SIZE as the partition variable. Small firms are defined as those that are below the median percentile of the *SIZE* variable. The variable *FAIL* equals one if a firm is located in a CBSA region that has a branch of a failed bank, and zero otherwise. Standard errors, reported in parentheses, are clustered at the firm level. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and * respectively.

Table 3: The Effect of Bank Failures on Team Persistence

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample			Gender		
				Male	Female	Mixed
FAIL	-0.008	-0.075***	-0.067***	-0.075***	-0.036	-0.070***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.026)	(0.010)
CLOSE*FAIL		0.047***	0.047***	0.044***	0.064*	0.054***
		(0.007)	(0.007)	(0.007)	(0.030)	(0.011)
PAST*FAIL		0.212***	0.215***	0.214***	0.123**	0.188***
		(0.009)	(0.009)	(0.009)	(0.044)	(0.017)
FEMALE*FAIL		-0.004				
		(0.005)				
SMALL*FAIL		0.029***		0.032***	0.009	0.031**
		(0.005)		(0.006)	(0.025)	(0.009)
Observations	481,216	481,216	481,216	322,633	6,723	72,416
County-level controls	Y	Y	Y	Y	Y	Y
Field FE	Y	Y	Y	Y	Y	Y
Firm-Year FE	Y	Y	Y	Y	Y	Y
Inventor pair FE	Y	Y	Y	Y	Y	Y

Note: This table shows probit regression results for the effect of bank failures on the probability of team persistence at the inventor pair-year level. The marginal effects from predictive margins are displayed. This table presents estimated coefficients and standard errors from Eq. (2) in Column 1 and Eq. (3) in Columns 2-6. The dependent variable measuring team persistence is a dummy variable that is one if a pair of inventors reappeared on a patent within three years, and zero otherwise. The variable *FAIL* equals one if a firm is located in a CBSA region that has a branch of a failed bank, and zero otherwise. *CLOSE* takes the value of one if distance between two inventors in a team is less than 30 miles, and zero otherwise. *PAST* takes the value of one if a pair of inventors in year t produced a patent in the preceding three years, and zero otherwise. *FEMALE* equals one if a pair of inventors includes at least one female inventor, and zero otherwise. *SMALL* equals one if a pair of inventors works together on a patent that has two or three inventors, and zero otherwise. Standard errors, reported in parentheses, are clustered at the firm level. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and * respectively.

Table 4: Robustness Checks on Team Persistence

	(1) Failures of Out-of-Region Headquartered Banks	(2) Excluding CA	(3) Excluding Crisis	(4) Excluding Unknown Gender Team
FAIL	-0.059***	-0.064***	-0.085***	-0.073***
	(0.006)	(0.006)	(0.007)	(0.006)
CLOSE*FAIL	0.048***	0.042***	0.026	0.046***
	(0.006)	(0.007)	(0.014)	(0.007)
PAST*FAIL	0.211***	0.208***	0.227***	0.209***
	(0.011)	(0.011)	(0.014)	(0.009)
FEMALE*FAIL	-0.005	-0.009	0.005	0.000
	(0.006)	(0.005)	(0.012)	(0.006)
SMALL*FAIL	0.025***	0.024***	0.031*	0.031***
	(0.005)	(0.007)	(0.012)	(0.005)
Observations	449,503	320,660	365,960	401,779
County-level controls	Y	Y	Y	Y
Field FE	Y	Y	Y	Y
Firm-Year FE	Y	Y	Y	Y
Inventor pair FE	Y	Y	Y	Y

Note: This table includes various robustness checks on the effect of bank failures on team persistence. The robustness checks include failures of out-of-region headquartered banks, excluding California, excluding the financial crisis years (2007-2009), and excluding unknown gender teams. The table presents probit regression results, and the marginal effects from predictive margins are displayed. This table shows estimated coefficients and standard errors from Eq. (3). The dependent variable is the same as in previous tables, measuring team persistence. Standard errors, reported in parentheses, are clustered at the firm level. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and * respectively.

Table 5: Results using Alternative Time Windows of Team Persistence

	(1) PAIR_PERSIST_2YR	(2) PAIR_PERSIST_4YR
FAIL	-0.067***	-0.079***
	(0.006)	(0.006)
CLOSE*FAIL	0.040***	0.049***
	(0.007)	(0.007)
PAST*FAIL	0.200***	0.216***
	(0.009)	(0.009)
FEMALE*FAIL	-0.003	-0.004
	(0.005)	(0.005)
SMALL*FAIL	0.024***	0.031***
	(0.005)	(0.005)
Observations	481,216	481,216
County-level controls	Y	Y
Field FE	Y	Y
Firm-Year FE	Y	Y
Inventor pair FE	Y	Y

Note: This table reports probit regression results for the effect of bank failures on the probability of team persistence. Observations are at the inventor pair-year level from 2000-2012. The marginal effects from predictive margins are displayed. This table shows estimated coefficients and standard errors from Eq. (3). The dependent variable measuring team persistence is a dummy variable that equals one if a pair of inventors reappeared on a patent within two or four years, and zero otherwise. Standard errors, reported in parentheses, are clustered at the firm level. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and * respectively.

Table 6: Differential Effects of the Intensity of Bank Failures on Team Persistence

	(1)	(2)	(3)	(4)	(5)
	All	0.1	0.2	0.3	0.4
INTENSITY	-0.442***	-0.362***	-0.278***	-0.206***	-0.147***
	(0.069)	(0.045)	(0.023)	(0.008)	(0.010)
CLOSE*INTENSITY	0.307***	0.251***	0.193***	0.143***	0.102***
	(0.049)	(0.037)	(0.029)	(0.024)	(0.021)
PAST*INTENSITY	1.020***	0.836***	0.642***	0.475***	0.338***
	(0.055)	(0.049)	(0.057)	(0.067)	(0.070)
FEMALE*INTENSITY	-0.074*	-0.061*	-0.047*	-0.035	-0.025
	(0.038)	(0.031)	(0.024)	(0.018)	(0.013)
SMALL*INTENSITY	0.211***	0.173***	0.133***	0.098***	0.070***
	(0.033)	(0.027)	(0.022)	(0.019)	(0.017)
Observations	481,216	481,216	481,216	481,216	481,216
County-level controls	Y	Y	Y	Y	Y
Field FE	Y	Y	Y	Y	Y
Firm-Year FE	Y	Y	Y	Y	Y
Inventor pair FE	Y	Y	Y	Y	Y

Note: This table reports probit regression results using a continuous measure of bank failures. The intensity is measured as the ratio of the total number of branches of failed banks to the total number of branches of all banks. Observations are at the inventor pair-year level from 2000-2012. The marginal effects from predictive margins are displayed. This table shows estimated coefficients and standard errors from Eq. (3). The dependent variable measuring team persistence is a dummy variable that equals one if a pair of inventors reappeared on a patent within three years, and zero otherwise. Standard errors, reported in parentheses, are clustered at the firm level. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and * respectively.

Appendix

Table A1: Variable Definitions and Sources

Variable	Description	Source
FAIL	An indicator variable that equals 1 if a CBSA region has at least one failed branch	FDIC and authors' calculations
INTENSITY	Ratio of the total number of branches of failed banks to the total number of branches of all banks by CBSA region and year	FDIC and authors' calculations
PAIR_PERSIST	An indicator variable that equals 1 if a pair of inventors in year t reappeared on a patent within the next three years (t+3) at the same firm	USPTO and authors' calculations
CLOSE	An indicator variable that equals 1 if distance between inventors in a pair is less than 30 miles	USPTO and authors' calculations
PAST	An indicator variable that equals 1 if a pair of inventors in year t produced a patent within the preceding three years (t-3) at the same firm	USPTO and authors' calculations
FEMALE	An indicator variable that equals 1 if a pair of inventors includes at least one female inventor	USPTO and authors' calculations
SMALL	An indicator variable that equals 1 if a pair of inventors comes from a team of two or three inventors	USPTO and authors' calculations
SIZE	Natural logarithm of the book value of total assets measured at the end of fiscal year t	Compustat

Table A2: Time Lags in Patent Process

Time Lag	N	Mean	SD	Min	Max
Invention – Application Year	165,531	0.238	0.572	0	12
Application – Grant Year	165,531	3.536	1.676	0	14
Invention - Grant Year	165,531	3.774	1.755	0	15

Note: This table reports the time lags for patents in our sample period from 2000-2012. If the earliest application date was preceded by an application in a foreign jurisdiction, we use the foreign application (priority) date as the invention date.

Table A3: Distribution of Firm by Types of Innovation

Lab Type	Freq.	Percent	Cum.
0 (Dry Lab)	1,263	76.08	76.08
1 (Wet Lab)	370	22.29	98.37
2 (Mixed Lab)	27	1.63	100
Total	1,660	100	100

Note: This table reports the distribution of firms by types of innovation in our sample period from 2000 to 2012. A firm is defined as a "Wet Lab" if most of its patents are in chemical fields, and as a "Dry Lab" if most of its patents are in non-chemical fields. We define a firm as a "Mixed Lab" if one-half of its patents are in chemistry.