From Competitors to Partners: Banks' Venture Investments in Fintech

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Keywords: Fintech, Bank, Venture Investments, Competition, Collaboration

JEL classification: G21, G24

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We hypothesize and find evidence that banks use venture investments in fintech startups as a strategic approach to navigate fintech competition. We show that banks' venture investments have increasingly focused on fintech firms in systematic ways. We find that banks facing greater fintech competition are more likely to make venture investments in fintech star- tups. Banks target fintech firms that exhibit higher levels of asset complementarities with their own business. Finally, instrumental variable analyses show that venture investments increase the likelihood of operational collaborations and knowledge transfer between the bank investor and the fintech investee.

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1 Introduction

Banks regularly make venture investments in startup companies. Unlike traditional venture capital funds, banks' investments have strategic motives. Hellmann et al. (2008) show that banks invest in startup firms to foster relationships and cultivate future lending businesses. Thus the financial investment in the startup firm helps to augment the investing bank's core lending business. However, the banking industry's competitive landscape has undergone significant transformations, primarily due to the emergence of fintech firms. The rise of fintech companies represents a formidable new competitive threat for traditional banks, with implications for the financial sector and the overall economy, and for policymakers.

In light of these changes, has the strategic focus of banks' venture investment also evolved? We hypothesize and find evidence that banks have used venture investments in fintech startups to deal with the fintech competition. We document a rapidly increasing trend over the last two decades in the number of banks making investments in fintech startups and the dollar amount of these investments. Among 75 public banks and banking holding companies that have made venture capital investments during 2001-2022, 51 of them have invested in 323 fintech startups. Whereas only about 5 banks invested in fintech startups each year before 2011, 24 banks invested in fintech startups in 2022. The annual investments increased from $21 million in 2001 to $485 million in 2022 (peaked in 2021 with $1.4 billion investments). Banks' increasing investments in fintech are above and beyond the overall growth of the fintech industry. The average annual growth rate for the fintech industry is 19.5% during 2001-2022 in terms of the number of fintech financing rounds and 31.5% in terms of aggregate dollar amount raised. In comparison, the average annual growth rate of banks' fintech investment during the same period is 29.5% in terms of deals and 187.2% in terms of dollar amount. In 2021, about 16% of money raised in equity deals for VC-backed startups went to fintech firms; in contrast, 35% of banks'

venture investments went to fintech firms.

There are several reasons why venture investments in fintech startups can be a solution to banks' fintech challenges. First, investment relationships can foster technological collaboration and knowledge transfer between banks and fintech startups. By investing in a fintech startup, a bank can learn from the innovative approaches of the fintech investee, incorporate their technology into their own operations, or encourage the investee to develop solutions tailored to the bank's specific needs. Such technological collaboration enables banks to stay competitive in the rapidly evolving fintech landscape. Second, investment relationships can facilitate business collaborations. Through partnerships, a bank investor and a fintech investee can combine their strengths to offer more comprehensive services, e.g., through cross-selling financial products and services to each other's customer base. Such business collaboration allows both parties to expand their market reach.

Equity investments facilitate both types of collaborations because they help overcome a significant hurdle for collaborations. The concern often revolves around the fear that the party receiving the technology (or customer clientele) will use it at the expense of the providing party when contracting on competition activities is difficult or impossible. Equity investments address this concern by fostering relationship and trust between the two parties and by creating financial incentives to ensure cooperation and discourage ex post opportunistic behaviors (Hellmann, 2002; Mathews, 2006).

Under the thesis that banks use investments in fintech startups as a means to address their fintech challenges, we formulate several hypotheses. First, banks tend to increase their venture investments in fintech startups when they encounter more intense competition from fintech firms. Second, banks target fintech firms that exhibit higher levels of asset complementarities with their core business. In other words, banks are more likely to invest in fintech startups that offer operating or innovative synergies. Third, financial investments by banks in fintech startups results in increased probabilities of operational collaborations and knowledge transfer between the bank investor and the fintech investee.

To test our first hypothesis—i.e., banks' investments in fintech startups increase with the fintech competition they face, we measure fintech competition as the growth rate of the market share of mortgage lending by fintech firms. Mortgage lending is an important market in which fintech lenders and traditional banks compete with each other and for which we have comprehensive data. Fintech lending on average increases over time, but we focus on the cross-sectional variations in the level of competition banks encounter depending on their locations. Consistent with our hypothesis, we find that banks are more likely to invest in fintech startup firms when facing higher fintech competition. This result holds after controlling for bank and fintech firm characteristics as well as a battery of fixed effects. We also find that large, profitable, and innovative banks are more likely to make investments in fintech startups. The fintech firms banks invest in tend to be more mature and more innovative, and they are more likely to be in "banking and lending" and less likely to be in "insurance".

To test our second hypothesis—i.e., banks are more likely to invest in fintech firms with higher potential synergies, we construct several measures for the technological and business relatedness between a bank and a fintech startup. Based on the two firms' patent information, we measure the overlap between their technology classes (technological overlap) and the extent they cite each other's patents (cross citation). Based on their industry descriptions, we measure their business overlap. Using the method of Bena and Li (2014), we create 10 pseudo deals for each actual bank-fintech firm investment pair and use the matched sample in our analysis.

Our analysis shows that higher technological or business relatedness is associated with a higher likelihood for a bank-fintech pair to form an actual investment relationship. This is true for each type of measure for technological and business relatedness. In terms of the economic significance, one-standard-deviation increase in a measure of technological and business relatedness is associated with 2-4% higher probability of an actual investment. These effects are substantial compared to the unconditional probability of an actual

investment pair of 9% in the matched sample.

To test our third hypothesis—i.e., financial investments by banks in fintech startups result in increased probabilities of operational collaborations between the investing bank and the fintech investee, we employ an instrumental variable analysis. Banks' choices of fintech startups are not random. To investigate whether there is any treatment effect of banks' fintech investments, we use a bank's market share in VC deals in a fintech firm's locale to instrument the fintech investment. Specifically, the instrument variable is the percentage of VC investment deals made by a bank in a local metropolitan and micropolitan statistical area (CBSA) before the actual (pseudo) fintech investment year. A bank's local market share, representing its availability for providing funding in the locale, is positively correlated with the bank's likelihood to invest in a fintech firm. This general funding availability, however, should not be directly related to its likelihood to collaborate with a specific fintech startup.

We engage in extensive manual data collection for business partnerships between 3,600 actual and pseudo pairs of bank investors and fintech investees. This involves scouting the fintech firms' websites and google searching news stories with both companies' names. We then classify the collaborations into three types: the bank investor utilizing technology from the fintech investee, the bank cross-selling to the fintech's customer base, and the fintech startup cross-selling to the bank's customer base. We find a stark difference between the likelihood of collaboration between actual and pseudo investor-investee pairs. Among the actual investment pairs, 29.6% of them have business partnerships. The vast majority of the partnerships (27.4% out of 29.6%) were formed after the financial investment. In contrast, the percentage of pseudo-investment pairs that have formed business partnerships is less than 2%. Our 2SLS regressions strongly support that financial investments result in higher post-investment collaborations.

Finally, we also find that an investment relationship between a bank and a fintech firm increases the technological relatedness among their new patents filed after the investment.

Specifically, banks' new patents after the investments are more likely to cite the fintech investee's patents, controlling for their cross-citations in the past. The evidence is consistent with the financial investment facilitating knowledge transfer.

Our paper resides at the intersection of banking and fintech and contributes to both literatures. First, this paper adds to our understanding of how banks adapt to a changing financial market in the face of fintech's disruptive force. Existing papers show that banks invest more in information technologies (Vives and Ye, 2021; Jiang et al., 2022b), change hiring strategies (Jiang et al., 2021), and provide more digital service (Jiang et al., 2022a) in response to changing preferences of consumers and the entry of fintech. Our paper focuses on banks' venture investment as a solution to the fintech disruption. Hellmann et al. (2008) study banks' venture investments during 1980-2000 and show that one objective of banks' venture investment is to build relationships with the startups so that they can lend to these firms later. We present evidence that banks' strategic focus has shifted in recent years when making venture investments. The growth of fintech startups presents both challenges and opportunities to banks. Many banks choose to build relationships with startups through financial investments so that they can form operational partnerships in the future.

Several recent papers also study banks' investments in fintech firms. Bellardini et al. (2022) and Li et al. (2023) document that banks tend to invest in fintech firms in a later stage of development and prefer financial-specialized firms over technological-specialized ones. Li et al. (2023) find that banks outperform independent venture capitalists (VCs) in terms of higher IPO exit rates. On the other hand, Carlini et al. (2022) report negative stock price reactions when banks invest in fintech firms. Chemmanur et al. (2023) investigate corporate investments (including those of banks) in fintech startups and document enhanced performance for both investees and investors. Different from these papers, we focus on the strategic motives of banks when they make investments in fintech firms. We find evidence that fintech competition and ex-ante synergies are important drivers for

financial investments and document extensive post-investment operational collaborations.

Second, our paper also adds to the fintech literature. Existing papers have documented the rise of fintech and its disruptive impact on financial incumbents. Buchak et al. (2018) find that fintech shadow banks charge higher rates than traditional banks for providing convenience to high-quality borrowers. Fuster et al. (2019) study the role of technology in mortgage lending and find fintech lenders process mortgage loan applications faster than traditional banks. Gopal and Schnabl (2022) show that finance companies and fintech lenders increased lending to small businesses after 2008. Tang (2019) finds that P2P lending is a substitute for banks with respect to marginal borrowers and a complement with respect to small loans. Di Maggio and Yao (2021) show that fintech lenders acquire market share in the personal credit market by lending first to higher-risk borrowers and then to safer borrowers and making credit decisions based mainly on hard information. On the credit supply side, Jagtiani et al. (2021) find fintech lenders have greater market shares in places with lower credit scores and higher mortgage denial rates; Allen et al. (2022) find that fintech lenders are more responsive to increased mortgage demand caused by natural disasters than traditional banks. Our paper presents evidence that fintech firms can also benefit from working with traditional banks, both through banks' financial investments and the business collaborations the former help foster.

2 Sample and Data

2.1 Fintech startups and bank investors: treatment and control samples

We obtain our sample of fintech startups and their financing information from Crunchbase. Crunchbase provides financing round-level information such as firm characteristics, deal characteristics, and investor characteristics. We require startup firms to be US-based VC-

backed firms.[1] We focus on equity deals and exclude deals that are classified as "Convertible Note," "Debt Financing," "Equity Crowdfunding," "Funding Round," "Grant," "Initial Coin Offering," "Non-Equity Assistance," "Secondary Market," "Post-IPO Secondary," and "Product Crowdfunding."

We classify startups into fintech and non-fintech firms based on Crunchbase's descriptions of their industry group (Crunchbase variable name "org_category_groups_list") and industry ("org_category_list").[2] Specifically, a startup is classified as fintech if it satisfies one of the following criteria: (1) Its industry description includes any of the following words: FINTECH, CROWDFUNDING, CRYPTOCURRENCY, FUNDING PLATFORM, INSURTECH, MOBILE PAYMENTS, TRADING PLATFORM, and VIRTUAL CURRENCY. (2) The industry group includes FINANCIAL SERVICE and one of the following keywords: ARTIFICIAL INTELLIGENCE, INFORMATION TECHNOLOGY, INTERNET, MOBILE, and SOFTWARE. We identify 8,836 financing rounds for 4,269 unique fintech firms during 2001-2022.[3]

We further label a fintech firm as in one or more fintech spaces based on its business descriptions ("org_short_description" in Crunchbase) and industry descriptions ("org_category_list" in Crunchbase): "Payments," "Banking & Lending," "Wealth Management," "Crypto-related," "Trading & Exchange," "AI, Cloud & IT," and "Others." The classification details are in Appendix A3. Fintech startups can operate in multiple fintech spaces.[4]

Next, we identify an investor as a bank if it is a public commercial bank, or a public

[1] That is, we require firms to either have received investments from at least one investor with investor type "venture capital" or "corporate venture capital", or to have had a financing event labeled as "venture round". This is motivated by several reasons. First, non-VC-backed firms tend to be of a distinct group. For example, many non-VC-back firms have no definite plans for exit and can remain private forever (e.g., see Kown et al., 2020). Second, information on key investors is less available for non-VC-backed firms. Third, banks focus on VC-backed fintech firms.

[2] Crunchbase assigns each company into one or more of 47 industry groups and 744 industries. For the detailed list of industry groups and industries, please see https://support.crunchbase.com/hc/en-us/articles/360043146954-What-Industries-are-included-in-Crunchbase-.

[3] Note that we require both the startup and investor to be based in the US. If we relax this requirement and include non-US-based fintech firms, there are 36,994 financing rounds for 17,444 fintech firms.

[4] An exception is that a firm is classified as "AI, Cloud & IT" only if it is not in "Payments," "Banking & Lending," "Wealth Management," "Crypto-related," "Trading & Exchange"; otherwise most fintech firms can have this label.

bank holding company (BHC) or its division (such as a bank division or a corporate venture capital (CVC) division). We focus on public banks because private banks rarely make venture investments in fintech.[5]

Banking holding companies and banks are able to make equity investments in both public and private non-financial firms under several statutory and regulatory authorities. Banking organizations can do so through a subsidiary of Small Business Investment Corporations (SBICs). SBICs can invest up to 50% of a small business company. A bank's aggregate investment in SBICs is limited to 5% of the bank's capital and surplus. Under the Gramm-Leach-Bliley (BLB) Act, however, BHCs have much greater flexibility and can engage in a broad range of merchant banking activities. Permissible merchant banking activities are broadly defined to include "investments in any amount of the shares, assets, or ownership interests of any type of non-financial company".[6]

We start with the list of bank holding companies and commercial banks in the Call Report and Y9-C data. We employ the following steps to match the list of public banks and BHCs with investors in Crunchbase: (1) Since Crunchbase does not provide the parent companies of investors, we manually collect the parent companies of financial investors.[7] (2) We perform a fuzzy name match between the list of banks and BHCs and the parent companies of investors in Crunchbase. (3) We manually review the fuzzy matching for all pairs with similarity scores less than 100.

We then use the CRSP-FRB link file provided by the Federal Reserve Bank of New York to get the list of public banks and BHCs.[8] We obtain their financial information from Compustat and stock information from CRSP.

[5]We matched all banks from Call Report database with financial investors in Crunchbase. We find that five private banks and BHCs (i.e., BancBoston Holdings Inc, Bank of St Elizabeth, Cogent Bancorp Inc, Wasatch Bancorp Inc, and Woodforest Bancshares Inc) participated in eight fintech deals during our sample period.

[6]For more information on the regulation, see https://www.federalreserve.gov/boarddocs/srletters/2000/sr0009a1.pdf.

[7]We identify financial investors as those whose industry group descriptions include the keyword "Financial Services".

[8]For more details of the CRSP-FRB link file, please see https://www.newyorkfed.org/research/banking_research/crsp-frb.

Appendix A1 lists the 51 public commercial banks and banking holding companies (or their subsidiaries) that have invested in fintech startups during our sample period. During 2001-2022, these investors participated in 475 financing rounds of 323 unique fintech firms, and formed 622 observations bank-fintech round combinations: 40% (249) of them are invested directly by commercial banks or BHCs; 35% (216) of them are invested by BHC's CVC arms; 15% (96) of them are invested by BHC's bank divisions; 10% (61) of them are invested by BHC's other divisions. Hereafter we refer to all of them as banks.

After imposing the requirement of nonmissing deal size and firm age for the fintech firm and nonmissing financials for bank investors, our treatment sample includes 511 bank-fintech round combinations during 2001-2022. To analyze the determinants and impact of these investments, we need a control group of bank-fintech firms that have no investment relationships. Instead of including a vast universe of all possible combinations of banks and fintech firms, we construct two control samples that are more comparable to the actual investment pairs, following the methods of Bena and Li (2014). For each actual bank-fintech investment deal, we create 10 pseudo deals by matching the actual bank investor with five pseudo fintech investees and matching the actual fintech investee with five pseudo bank investors. The candidates for pseudo fintech investees are fintech firms that have had financing rounds in the same year as the actual investment deal but have not received investments from banks. The candidates for pseudo bank investors are all banks and BHCs in Compustat that did not make fintech investments that year.

First, we create a Random Control Sample. That is, we randomly select five fintech firms from the pool of pseudo investee candidates, and five banks from the pool of pseudo investor candidates.

Second, we create a propensity score matching (PSM) Control Sample. We select five fintech startups from the pool of pseudo investee candidates, using propensity score matching based on firm age and the size of the financing round. We match based on firm age and financing size because banks tend to invest in more mature and larger fintech startups

(more discussion is in Section 3.2). We select five banks from the pool of pseudo investor candidates, using propensity score matching based on bank size and book-to-market ratio. Size and book-to-market are two variables that commonly affect firms' investment decisions.

2.2 Variable constructions

In this subsection, we describe how we construct key variables that may drive banks' investments in fintech firms (i.e., fintech competition faced by each bank, the two firms' technological and business relatedness), and variables that measure the results of such investments (i.e., business partnerships between a bank-fintech pair, and post-investment change in technological relatedness). For post-investment analysis, we focus on the first deal between each bank-fintech pair, and examine deals by the end of the year 2021, leaving at least 1 year for changes to happen.

2.2.1 Fintech competition

We measure fintech competition with the growth rate of the market share of fintech shadow banks in mortgage lending: mortgage lending is part of banks' core business in which fintech shadow banks present fierce competition and comprehensive data is available for this market. Different banks can face different levels of fintech competition. We measure the fintech competition faced by each bank based on its branch locations.

Buchak et al. (2018) define shadow banks as non-depository lenders and fintech shadow banks as those that have a strong online presence and process most of their applications without human involvement. Fuster et al. (2019), Jagtiani et al. (2021) and Berg et al. (2022) have followed the same definition and updated the list of fintech shadow banks. We use the list of ten fintech lenders from these papers.[9]

[9]The ten fintech lenders are AmeriSave, Better Mortgage, CashCall, Everett Financial (Supreme), Guaranteed Rate, LoanDepot, Movement Mortgage, Quicken, Rocket Mortgage loans, and SoFi.

We use mortgage loan data for first lien and 1-4 family homes from Home Mortgage Disclosure Act (HMDA) Data to calculate the market share for each lender. We first measure fintech market share at the county level, i.e., the percentage of mortgage loan amount originated by fintech shadow banks for customers in a given county-year. We then calculate the average fintech market share across counties where a bank has a presence, weighted by the number of branches in each county. Bank branch data are obtained from the Federal Financial Institutions Examination Council (FFIEC).[10] Finally, we calculate the growth rate of the average fintech market share a bank is exposed to. Note that fintech market share depends on the number and the size of traditional banks in the area. Hence we focus on the growth rate to measure fintech competition: the faster fintech lenders make inroads, the greater the competition pressure banks encounter.

2.2.2 Measuring bank-fintech firm technological relatedness

We measure bank-fintech firm technological relatedness based on their patent information. We obtain patent and patent assignment data from the United States Patent and Trademark Office (USPTO) Bulk Data Storage System website.[11] We perform a fuzzy name match between standardized names of patent assignees and fintech startups (or banks). We make use of the name standardization code from the NBER Patent data project.[12] We supplement our patent data by repeating the above matching process with patent assignment data from PatentsView.[13] Our patent citation data are also from PatentsView.

The first measure of the technological relatedness between a bank and a fintech startup measures the similarity of their innovation activities in the technology space. Following Jaffe (1986) and Bena and Li (2014), we define Technological Overlap as $\frac{S_{fintech}S'_{bank}}{\sqrt{S_{fintech}S'_{fintech}}\sqrt{S_{bank}S'_{bank}}}$, where the vector $S_{fintech} = \{S_{fintech,1}, ..., S_{fintech,K}\}$ captures the innovation activities for the fintech firm, and $S_{bank} = \{S_{bank,1}, ..., S_{bank,K}\}$ captures the innovation activities for the

[10] Data source: https://www.ffiec.gov/npw/FinancialReport/DataDownload.
[11] USPTO Bulk Data Storage System website: https://bulkdata.uspto.gov/.
[12] NBER Patent data project website: https://sites.google.com/site/patentdataproject/Home.
[13] PatentsView website: https://patentsview.org/download/data-download-tables.

bank, and $k \in (1, K)$ is the technology class index. $S_{fintech,k}$ ($S_{bank,k}$) is the ratio of the number of patents granted to the fintech startup (the bank) in technology class k to the total number of patents granted to the fintech startup (the bank) in all technology classes. The variable measures the cosine similarity between the technology classes spanned by the two firms' patents.

The second set of measures of technological relatedness looks at cross-citations between the two firm's patents: (1) *Cross Citation* is a dummy variable that equals one if either any patent granted to the bank cites any patent of the fintech startup or any patent granted to the fintech startup cites any patent of the bank, and zero otherwise; (2) *Cross Citation by Bank* is a dummy variable that equals one if any patent granted to the bank cites any patent of the fintech startup, and zero otherwise; (3) *Cross Citation by Fintech* is a dummy variable that equals one if any patent granted to the fintech startup cites any patent of the bank, and zero otherwise.

For all these variables, we restrict to patents granted before the bank invests in the fintech firm. We also want to measure their technological relatedness after the investment. We thus have a set of post-investment variables, *Post Cross Citation*, *Post Cross Citation by Investor*, *Post Cross Citation by Fintech* that are similarly defined as above but using patents granted after the investment.

2.2.3 Measuring bank-fintech business relatedness

We measure a bank and a fintech firm's business relatedness based on the descriptions of their industries ("org_category_list" in Crunchbase). *Overlap Business(#)* is the number of keywords that are in both firms' industry descriptions. *Overlap Business(%)* is the number of keywords that are in both firms' industry descriptions, divided by the total unique keywords from the two firms' industry descriptions. Crunchbase only provides current industry descriptions. Hence the business relatedness measures are static (not time-varying).

These two variables can be measured if both the bank and the fintech firm are covered

by Crunchbase. Hence for the tests involving these variables, we restrict pseudo banks to be in the CrunchBase database (i.e., they have participated in at least one financing event in Crunchbase). Due to this added constraint, we have fewer than 5 pseudo banks in some cases. The control sample is reduced from 5,110 observations to 3,571 observations.

2.2.4 Measuring bank-fintech firm partnership

For each actual and pseudo-bank-fintech investment pair (over 3500 of them), we hand-collect information on their business collaborations.[14] We do so by reviewing the fintech firm's website and by Google searching news stories with both companies' names. (Due to the relatively small size of fintech investees, banks do not usually discuss their investments in fintech firms or their business collaborations on their websites or in SEC filings.) We create a dummy variable, *Fintech-Bank Partnership*, that equals one if the two firms have ever formed a partnership apart from the investment relationship and zero otherwise. When a partnership is identified, we note its time which allows us to tell whether the partnership was formed before or after the bank invested in the firm. We also extract the description of the partnership.

We then manually read the description, classify the partnership into three types, and create dummy variables to indicate the types. *Fintech-Bank Partnership: Utilize Fintech Technology* is a dummy variable that equals one if the bank utilizes/incorporates the fintech firm's technology in its own website or app, and zero otherwise. For example, Live Oak Bank established a partnership with DefenseStorm in 2016 and implemented DefenseStorm's CyberSecurity and CyberCompliance for fraud prevention.[15] *Fintech-Bank Partnership: Cross Sell to Bank Customers* is a dummy variable that equals one if the fintech startup cross-sells its products to the customers of the bank, and zero otherwise. For

[14]For post-investment outcome analysis, we focus on the first deal of each bank-fintech firm pair by 2021 (328 of them). We find 10 pseudo deals for each actual deal in analysis based on a propensity score matching (see description in Section 2.1).

[15]For more details of the partnership, please see: https://defensestorm.com/wp-content/uploads/2023/05/DS-Live-Oak-Bank-Case-Study-05-12-22-FINAL.pdf.

example, in the partnership between American Express and Better.com in 2021, American Express offered its card members statement credits of $2,000 ($6,000) if they originate or refinance conforming (or jumbo) mortgage loans through Better.com.[16] Although the first type of partnership (the bank utilizing the startup's technology) can also be viewed as the startup reaching to the bank's customers, we differentiate the two types based on whether the end customers deal with and pay the startup firm directly: if yes, we classify it as cross-selling. *Fintech-Bank Partnership: Cross Sell to Fintech Customers* is a dummy variable that equals one if the bank cross-sells its products to the customers of the fintech startup, and zero otherwise. For example, in the partnership between Sterling Bancorp and Goalsetter (a finance app that focuses on financial education for the next generation) in 2021, Sterling National Bank will participate in Goalsetter's "Drafted" initiative, a campaign to bring savings accounts to one million students in minority communities.[17]

3 Banks' increasing investment in fintech startups

3.1 Time trend

Banks have increasingly focused their venture investment on fintech in the last two decades. Out of 75 public banks that have made venture capital investments during 2001-2022, 51 of them have invested in fintech startups. Figure 1 plots the number of banks making new investments in fintech firms each year. While only around 5 banks invested in fintech startups each year in the first decade of the 21st century, 24 banks invested in fintech startups in 2022. The number of banks investing in only non-fintech startups, however, has stayed about the same, during the same period. As a result, among all the banks that make investments in VC-backed startup firms, the percentage of banks investing in fintech startups

[16]For more details of the partnership, please see: https://www.nationalmortgagenews.com/news/american-express-partners-with-rocket-and-better-com-on-mortgage-offer.

[17]For more details of the partnership, please see: https://www.globenewswire.com/news-release/2021/02/16/2176345/0/en/Sterling-National-Bank-Partners-with-Goalsetter-to-Bring-Savings-Accounts-to-One-Million-Students-in-Underserved-Communities.html.

has surged from about 20% in 2001 to over 70% in 2022. In comparison, the percentage of all investors in Crunchbase investing in VC-backed fintech startups also increased over the years, but the increasing trend is much flatter, reaching about 34% in 2022.

Figure 2 plots the number of financing rounds (deals) participated by banks each year. Prior to 2014, there were only a few instances of fintech investments by banks each year. However, this number surged significantly since, reaching 66 deals in 2022 (peaked in 2021 with 94 deals). In comparison, the number of non-fintech deals by banks only experienced a modest increase from 100 in 2001 to 122 in 2022. Hence the percentage of fintech deals invested by banks has increased sharply from 4% in 2001 to about 35% in 2022. Beginning in 2006, banks' fintech investment percentage surpassed that of all investors. In 2022, the percentage of fintech deals for all investors is 15%, way below the 35% for banks.

Figure 3 plots the dollar amount of investments made by banks in fintech firms each year, assuming an equal amount of investment from each investor in a financing round.[18] The investment amount started to take off in 2014, growing from $112 million in 2014 to $485 million in 2022 (peaked in 2021 with $1.4 billion investments). Finally, Figure 4 plots the cumulative number of fintech firms that banks have invested in over time. By 2022, 51 banks have invested in 323 unique fintech firms (in 475 financing rounds).

3.2 Type of fintech firms invested by banks

Figure 5a compares the investment stage of fintech deals with and without bank investors during our sample period. Banks tend to invest in later-stage deals. Notably, less than 10% of bank investments in fintech are allocated to early-stage investments, including angel rounds, pre-seed, and seed rounds. In contrast, early-stage investments comprise 46% of investments by non-bank investors. On the other hand, more than 40% of bank

[18] Crunchbase provides the total deal size of each financing round but not the investment amount of each investor (the latter information is not available in any other databases or public sources either).

investments in fintech are directed towards financing rounds of Series A and B, and 49% towards late-stage investments, namely Series C+ rounds, corporate rounds, and private-equity rounds. In contrast, 34% of non-bank investors' fintech investments are in Series A and B, and only 20% of their investments fall into the late-stage category.

Figure 5b compares the average deal size for financing rounds with and without bank investors, for rounds of early stage, Series A+B, and late stage, separately. It is clear from the figure that for financing rounds in every stage, those who participated by banks raised significantly more money than those without banks. The findings that banks tend to invest in later-stage and larger deals are consistent with those of Hellmann et al. (2008). Also consistent with existing studies (Li et al. (2023)), we find that fintech firms with bank investment have high IPO exit rates (4.6% vs. 0.9%), similar rates of being acquired (20.4% vs. 15.8%), and lower failure rates (14.6% vs. 26.3%).[19]

Figure 6 plots the percentage of fintech deals with and without bank investment in different fintech spaces. Banks display greater preferences for "Payments," "Banking & Lending", and "AI, Cloud & IT" than non-bank investors, each space comprising of 20% or more of banks' investments in fintech firms (in terms of the number of financing deals). These fintech sectors either align closely with banks' core business or offer significant technological complementarity. On the other hand, banks invest relatively less in "Insurance", "Crypto", and invest to the same extent in "Wealth management", "Trading & Exchange", and "Others" compared to other investors.

Moreover, fintech firms receiving bank investments exhibit greater innovation: during our sample period, 28.2% of fintech startups with bank investments have produced at least one patent, compared to 15.1% of fintech startups without bank investments . Banks investing in fintech are also more innovative than other banks: 58.8% of banks with fintech investments have produced at least one patent in our sample period, compared to 12.2%

[19]We classify a startup as failed if either Crunchbase labels it as such or it has not had a new funding round for at least four years. Using just the Crunchbase label, the failure rate is 7.7% vs. 10.7% for fintech firms with and without bank investment.

of banks without fintech investments.

Table 1 presents summary statistics of our treatment sample, in comparison with the two control samples. Panel A reports the characteristics of fintech startups. Consistent with Figure 5 and 5, it shows that fintech deals that receive bank investments are larger than those without bank investments: the average deal size of the treatment group is $55 million vs. $23 million for the random control group (these fintech firms also raise funds in the same year). Fintech firms receiving bank investments are more mature: the average firm age is 66 months vs. 45 months for the random control group. The differences in these two variables between the treatment group and PSM control group are much smaller but still exist, suggesting that banks tend to invest in larger and more mature fintech firms. Consistent with Figure 6, Table 1 Panel A shows that the difference between fintech firms with and without bank investors (treatment vs. control fintech firms) is positive and significant for "Banking & Lending", and negative and significant for "Insurance" and "Crypto".

Table 1 Panel B presents summary statistics of banks. Notably, banks making fintech startups are larger in size. They are also more profitable, have better stock performance, and produce more patents. On the other hand, however, they experience lower growth rates. This indicates banks make fintech investments when they can (being large and profitable) and when they need to (lower growth rates incentivize pursuing new growth opportunities).

Table 1 Panel C reports the business and technological connectedness between bank investors and fintech investees. The treatment group demonstrates higher connectedness by every measure: they have higher Overlap Business, higher technological overlap, and higher cross citations. This is the first indicator that banks choose to invest in fintech firms that offer greater ex-ante synergies with them.

In summary, treatment groups tend to differ from control groups, which is not surprising. As common in the literature (Bena and Li, 2014; Bereskin et al., 2018; Li et al., 2019),

the PSM control group is much more similar to the treatment group than the random control group but differences still exist, even on the matching variables, which indicates investments do not happen randomly. We therefore report analysis results using the PSM matching sample in the paper (and robustness tests using the random matching sample in the internet appendix), and control for all bank and fintech characteristics in the analyses.

4 Drivers for banks to invest in fintech

In this section, we estimate selection models to test our hypotheses regarding what drives banks to invest in fintech firms.

4.1 Fintech competition

We hypothesize that banks facing greater competition from fintech firms are more likely to invest in the sector. We measure fintech competition based on the growth rate of the fintech market share in mortgage lending in the areas a bank operates in. Fintech lenders and traditional banks compete for borrowers in this market, and we have comprehensive data for mortgage lending from HMDA.

Table 1 Panel B presents the summary statistics of the fintech competition measure. The HMDA mortgage data starts from 2007 with the first fintech loans appearing in 2008. We therefore measure fintech competition from 2009 through 2021 (matched to investment deals during 2010-2022). The average competition faced by actual bank investors is 34.6%, which is significantly higher than the average competition faced by pseudo banks in both the random control sample (23.8%) and the PSM control sample (24.6%).

To examine whether and how fintech competition drives banks' investment in fintech

firms, we run the following linear probability regression with our matched sample.

$$\begin{aligned} Actual\ Investment_{j,t} &= \alpha + \beta_1 Fintech\ Competition_{j,t-1} + BankCharacteristics_{j,t-1}\Gamma \\ &\quad + DealGroupFE + BankStateFE + \epsilon_{j,t} \end{aligned} \tag{1}$$

The dependent variable, $Actual\ Investment_{j,t}$, is a dummy variable that equals one if it is an actual investment deal made by bank j at time t and zero for a pseudo deal. $Fintech\ Competition_{j,t-1}$ is fintech competition bank j faces. $BankCharacteristics_{j,t-1}$ represents a set of bank characteristics, including *# New Patents*, *Bank Size*, *BM* (book-to-market ratio), *Sales Growth*, *ROA*, and *Stock Return*. All variables are defined in Table A.2 in the appendix.

The variable of interest of this test is the fintech competition a bank faces, which is a bank-specific characteristic. Thus, for this test, our matched sample contains five pseudo deals for every actual deal, each pseudo deal matching the actual fintech investee with a pseudo bank investor. We do not include the five pseudo deals that match the actual bank investor with pseudo fintech investees, because *fintech competition* will be the same for these five pseudo deals.

We use linear probability regressions as opposed to logit regressions because they allow the inclusion of many fixed effects and because of their ease of interpretation of regression coefficients. We include deal group fixed effects and bank headquarters state fixed effects. Deal group fixed effects are to indicate every group of 6 deals—the actual deal and its matching pseudo deals. These fixed effects mitigate several endogeneity concerns. Including bank state fixed effects ensures that the results are not driven by banks headquartered in certain states. Deal group fixed effects (which supersedes year fixed effects) absorb the economy-wide correlation between fintech competition and fintech investment, so that identification comes from cross-sectional variations in fintech competition.

Table 2 presents the linear probability regression results, with more fixed effects added moving from Column 1 to Column 3. For brevity, we report results using the PSM-matched

sample. The results using the randomly matched sample (randomly drawn 1,000 times) are robust and are reported in Tables IA.1 in the internet appendix.

The coefficient of the key variable—*Fintech Competition*—is positive and statistically significant at the 1% level across all first two columns. This indicates a positive correlation between a bank's exposure to fintech competition and its likelihood of investing in fintech startups. The economic significance of the variable is substantial. Based on the estimates of Column (3), a one-standard-deviation increase in fintech competition (0.36) increases the fintech investment likelihood by 2 percentage points, which is significant compared to the unconditional probability of 16.7% in the matched sample. Furthermore, the coefficients related to bank characteristics indicate that larger banks, more profitable banks, and banks with better stock performance are more likely to invest in fintech firms.

4.2 Business and technological relatedness

In this subsection, we test the hypothesis that a bank is more likely to invest in a fintech firm if their businesses or technologies are more related. We estimate the following regression using the matched sample.

$$\begin{aligned} Actual\ Investment_{i,j,t} \;=\; & \alpha + \beta_1 Business\ or\ technological\ relatedness_{i,j,t-1} \\ & + FintechCharateristics_{i,t-1}\Phi + BankCharacteristics_{j,t-1}\Gamma \\ & + DealGroupFE + BankStateFE + FintechStateFE \\ & + DealStageFE + \epsilon_{i,j,t} \end{aligned} \tag{2}$$

The dependent variable, $Actual\ Investment_{i,j,t}$, is a dummy variable that equals one if it is an actual investment deal made by bank j in fintech firm i at time t and zero for a pseudo deal.Our first measure for technological relatedness is $Technological\ Overlap_{i,j,t-1}$, i.e., the cosine similarity of fintech startup i's and bank j's technology classes of their

patents prior to the investment deal. Our second set of measures for technological relatedness is the cross citations between the two firms' patents: *Cross Citation*, *Cross Citation by Bank*, and *Cross Citation by Fintech*. The set of measures for business relatedness includes *Business Overlap (#)* and *Business overlap (%)*. These variables of interest measure the characteristics of bank-fintech pairs. Therefore, we use a matched sample that contains 10 pseudo deals for every actual deal, each pseudo deal matching an actual fintech investee with a pseudo bank investor or an actual bank investor with a pseudo fintech investee. Deal group fixed effects indicate every group of 11 deals—one actual deal and its 10 matching pseudo deals. Equation (1) focuses on banks' decisions and includes bank state fixed effects in addition to deal group fixed effects. Equation (2) considers both bank and fintech's characteristics and also includes fintech state fixed effects and deal stage fixed effects. Each deal is classified into one of three deal stages: early stage, Series A&B, and late stage.

Table 3 reports the regression result using *Technological Overlap* as the variable of interest. The coefficient of *Technological Overlap* is positive and significant in all three columns. This finding suggests that technological overlap between a bank and a fintech startup is positively correlated with the likelihood of the bank investing in the fintech startup. The economic significance of the variable is also substantial. Based on the estimates of Column (3), a one-standard-deviation increase in technology overlap (0.19) increases the fintech investment likelihood by 1 percentage point, which is significant compared to the unconditional probability of 9% in the matched sample.

For coefficients related to fintech firms characteristics, we find that more mature firms, firms seeking large financing, and firms in "Bank and Lending" are more likely to receive bank investment. On the other hand, firms in "Insurance" are less likely to receive bank investment. Coefficients related to bank characteristics remain similar to those in Table 2.

Table 4 reports the regression result using patent cross citations as the variables of interest. In Panel A of Table 4, the coefficient of *Cross Citation* is positive and statistically

significant at the 1% level across all three columns. Economically, a one-standard-deviation increase in cross citation (0.09) increases the fintech investment likelihood by 1.8 percentage points, according to the estimates of Column (3). Panel B of Table 4 include both *Cross Citation by Bank* and *Cross Citation by Fintech*. Both variables have positive coefficients but only *Cross Citation by Fintech* is significant. This seems to suggest that knowledge transfers from banks to fintech early on play a more important role in affecting deal formation.

Table 5 reports the regression result using business-relatedness measures as the variables of interest. Panel A of Table 5 presents the regression results using *Business Overlap (#)* as a measure of business relatedness between a bank and a fintech startup. *Business Overlap (#)* quantifies the number of industries in which both the bank investor and the fintech startup operate. The effect of *Business Overlap (#)* is consistently positive and statistically significant at the 1% level across all three columns. The economic significance of the variable is also substantial. Based on the estimates of Column (3), a one-standard-deviation-increase in the number of overlapping businesses (0.811) results in a 3.2% higher probability of banks investing in fintech startups, which is a 35% increase from the unconditional probability of a bank-fintech actual pair of 9% in the matched sample.

Panel B of Table 5 reports the regression results using *Business overlap (%)* as a measure for business relatedness. *Business overlap (%)* represents the percentage of industries in which both the bank investor and the fintech startup are engaged. Similar to Panel A, the effect of *Business overlap (%)* is positive and significant at the 1% level across all three columns. The findings are economically significant. Based on the estimates of Column (3), a one-standard-deviation-increase in the percentage of overlapping businesses (14.3 percentage points) leads to a 4.3% higher likelihood of banks investing in fintech startups, which is significant compared to the unconditional probability of 9% in the matched sample.

In Tables IA.1-IA.4 in the internet appendix, we re-estimate regressions in Table 2-5,

but using the randomly matched sample (randomly drawn 1,000 times), instead of the PSM matched sample. In Tables IA.6-IA.7 in the internet appendix, we repeat regressions in Tables 3-5, but adding *Fintech Competition*. Our main results are robust that banks are more likely to make fintech investments when they face higher fintech competition, and they are more likely to invest in fintech firms that have greater business or technological relatedness with them.

5 Post-investment partnerships and knowledge spillovers

Next, we study the impact of banks' investments on the activities of both banks and fintech startups. To analyze post-investment activities, we focus on the first deal between a bank-fintech pair if the bank makes multiple investments in the fintech startup. We also examine deals by the end of the year 2021, leaving at least 1 year for changes to happen. These two data requirements reduce the number of bank-fintech observations to 328.

The analysis in Section 4 shows that banks' choices of fintech investees are not random. Nonetheless, we hypothesize that such investments also have treatment effects, e.g., to facilitate operational collaborations. As an equity holder, a bank investor will have access to private information about the fintech firm and will be in a better position to assess and design partnerships with the startup firm. Theory has also shown that equity investment can foster relationships and trust and create incentives to ensure cooperation and discourage ex post opportunistic behaviors (Hellmann, 2002; Mathews, 2006).

To isolate the treatment effects, we employ an instrumental variable (IV) analysis. We use the total percentage of VC investment deals made by a bank in a local Metropolitan and Micropolitan Statistical Area (CBSA) before the actual (pseudo) fintech investment deal to instrument the bank's fintech investment.[20] A bank's local market share, representing its availability for providing funding to the local market, is positively correlated with the

[20] Our results are robust to alternative instruments measuring VC market shares of banks in local metropolitan statistical areas (MSAs) or states.

bank's likelihood to make a fintech investment. This general funding availability, however, should not be directly related to its likelihood to collaborate with a specific fintech startup.

5.1 Business Partnerships: Technology Utilization and Cross-selling

We begin by examining business partnerships between banks and fintech startups. We hypothesize that investment relationships will facilitate such partnerships. We manually collect information on business partnerships for the 328 actual and 3,280 pseudo bank-fintech pairs and classify them into three types—the bank utilizing the fintech firm's technology, the bank cross-selling to the fintech firm's customers, the fintech firm cross-selling to the bank's customers.[21] We also collect information on the timing of partnership formation to determine whether it occurs before or after the financial investment. We exclude a small number of observations where timing information is not available, which reduces the matched sample from 3,608 to 3,587 observations.

Table 6, Panel A, presents summary statistics of bank-fintech partnerships for both the treated (actual investment pairs) and pseudo deals. Among the actual investment pairs, 29.6% of them have business partnerships with partnership time available, most of which (27.4% out of 29.6%) are formed after the bank has made an investment in the fintech firm. In contrast, the percentage of pseudo investment pairs that have formed business partnerships is less than 2%. This stark difference suggests that financial investment facilitates business partnerships. Interestingly, banks choose to make investments in the fintech firms before they form business partnerships. The timing points to treatment effects: if collaborations are solely due to selection effects, then they should be equally likely to occur before or after the financial investment.

Table 6, Panel A, also reports the occurrence of the three types of business partnerships

[21] We obtain from SDC a small number (36) of strategic alliances between any public banks and fintech firms. Analysis using this small sample also suggests that actual investment relationships lead to higher likelihoods of business partnership. Our manually collected data covers a much more comprehensive set of business partnerships. This is consistent with Schilling (2009)'s finding that SDC reports only a fraction of formally announced alliances. The problem can be more severe when a partner is a young startup firm.

between banks and fintech startups: 13% of actual investment pairs have post-investment partnerships that involve banks utilizing the technology of fintech startups; 11% of actual investment pairs have post-investment partnerships that enable fintech startups to cross-sell their products to bank customers; and 7% of actual investment pairs have post-investment partnerships that allow banks to cross-sell their products to the customers of fintech startups (a small number of pairs have multiple partnerships or their partnerships are classified into multiple types). This suggests that banks and fintech startups both benefit from these partnerships: they cross-sell to each other's customers with similar frequency, and both benefit when banks utilize startups' technology.

Table 6, Panel B, reports the frequency of bank-fintech partnerships for investee firms in different fintech spaces separately, for the treated sample. Not surprisingly, the partnership likelihood is highest for fintech firms in "AI, Cloud &IT" (35%). On the other hand, banks are least likely to form partnerships with fintech firms in "Trading & Exchange" (6%) and "Insurance" (13%). In terms of the types of partnerships, banks are most likely to use fintech technologies in "Crypto" (27%) and "AI, Cloud &IT" (24%), and most likely to cross-sell to customers of fintech firms in "Banking & Lending" (11%) and "Payments" (9%). Fintech firms in the following spaces are more likely to cross-sell to banks' customers (with likelihoods range between 12-13%): "Banking & Lending", "Wealth Management", "Payments", and "Others".

To investigate the causal effect of financial investment on the likelihood of post-investment business collaboration, we estimate the following 2SLS regressions:

1st stage:

$$\begin{aligned} Actual\ Investment_{i,j,t} \;=\; & \alpha + \beta_1 \%\ VC\ Deals\ in\ Local\ CBSA_{i,j,t-1} \\ & + FintechCharateristics_{i,t}\Phi + BankCharacteristics_{j,t}\Gamma \\ & + DealGroupFE + BankStateFE + FintechStateFE \\ & + DealStageFE + \epsilon_{i,j,t} \end{aligned} \tag{3}$$

2nd stage:

$$
\begin{aligned}
BankFintechPartnership_{i,j,t+1} \;=\; & \alpha + \beta_1 Instrumented\ Actual\ Investment_{i,j,t} \\
& + FintechCharateristics_{i,t}\Phi + BankCharacteristics_{j,t}\Gamma \\
& + DealGroupFE + BankStateFE + FintechStateFE \\
& + DealStageFE + \epsilon_{i,j,t} \qquad (4)
\end{aligned}
$$

The dependent variable of the second-stage regression, $BankFintechPartnership_{i,j,t+1}$, is a dummy variable equal to one if fintech startup i and bank j have become business partners after the investment. The instrument variable, $\%\ Deals\ in\ Local\ CBSA_{i,j,t-1}$, is the market share of investment deals made by bank j in the fintech startup i's local CBSA before the actual/pseudo investment year. $Instrumented\ Actual\ Investment_{i,j,t}$ is the predicted value of $Actual\ Investment_{i,j,t}$ from the 1st-stage regression. $FintechCharateristics_{i,t}$ represents a set of fintech i characteristics, including *# New Patents*, *Ln(Deal Amount)*, *Ln(Age at Deal)*, and a set of dummies indicating the fintech spaces of each fintech startup. $BankCharacteristics_{j,t}$ represents a set of bank j characteristics, including *# New Patents*, *Bank Size*, *BM*, *Sales Growth*, *ROA*, and *Stock Return*. We also include a set of fixed effects: BankStateFE (bank headquarters state fixed effects), FintechStateFE (fintech firm's headquarters state fixed effects), DealStageFE (investment round fixed effects), and DealGroupFE (deal group fixed effects that indicate a group of actual and its 10 pseudo deals). We dropped deals in which partnerships were without time information.

Column (1) of Table 8 presents the 1st-stage regression results. The coefficient estimate for *%VC Deals in Local CBSA* is positive and significant. In terms of economic significance, a one-standard-deviation-increase in the percentage of VC Deals in Local CBSA (i.e., 4.8% higher in market share) results in a 48% higher probability of banks investing in fintech startups. The F statistic is 22. Hence the instrument satisfies the relevance condition.

Column (2) of Table 8 presents the regression results for any type of post-investment

business partnership. The coefficient estimate for *Instrumented Actual Investment* is positive and significant, indicating that investment relationships have a positive impact on the likelihood of actual investment. Specifically, investment relationships increase the likelihood of forming a post-investment business partnership by 45%. Columns (3), (4), and (5) of Table 8 report the regression results for the three types of post-investment business partnerships. In two out of three columns, the coefficient estimate for *Instrumented Actual Investment* is positive and significant, albeit with varying magnitudes. Investment relationships lead to a 40% higher chance of forming a post-investment business partnership in which the bank utilizes the fintech firm's technology. Furthermore, investment relationships increase the likelihood of forming a post-investment business partnership by 8% which enables the fintech startup to cross-sell their products to the bank's customers. Lastly, investment relationships do not significantly affect the likelihood of forming a post-investment business partnership that facilitates banks in cross-selling their products to the existing customers of fintech startups.

5.2 Post-investment innovations

In this subsection, we test the hypothesis that bank investment in fintech firms will facilitate knowledge transfer between the two firms. We therefore expect to see the investment pairs' new patents will tend to have higher technological overlap and will cite each other more, compared to pairs without investment relationships. We estimate a 2SLS regression with the 1st stage the same as before and the 2nd stage as follows:

$$\begin{aligned} Technological\ relatedness_{i,j,t+1} \;=\; & \alpha + \beta_1 Instrumented\ Actual\ Investment_{i,j,t} \\ & + \beta_2 Technological\ relatedness_{i,j,t} \\ & + FintechCharateristics_{i,t}\Phi + BankCharacteristics_{j,t}\Gamma \\ & + DealGroupFE + BankStateFE + FintechStateFE \\ & + DealStageFE + \epsilon_{i,j,t} \end{aligned} \tag{5}$$

In the regression, we control for the two firms' pre-investment technological relatedness, as well as other bank and startup characteristics and fixed effects as those in Equation (3). Table 9 reports the 2nd-stage regression results using post-investment cross citation as the dependent variable. Column (1) shows that after controlling for pre-investment *Cross Citation*, the coefficient on *Instrumented Actual Investment* is positive and significant, suggesting that investment relationships increase banks and fintech firms' post-investment cross citations. We then differentiate the direction of knowledge transfers between banks and fintech firms and use post-investment *Cross Citation by Fintech* and *Cross Citation by Bank* as the dependent variable in Column (2) and (3), respectively. The coefficient estimate on *Instrumented Actual Investment* is positive in both columns but is only significant when the dependent variable is *Post-investment Cross Citation by Bank*. Thus, the evidence is stronger that investments facilitate banks' innovations utilizing the fintech firm's knowledge vs. the other way around. We also measure *Technological Relatedness* with post-investment *Technological Overlap* and find insignificant results in the 2nd-stage regression.

Overall, the results in this section show that VC investment in fintech firms facilitates business partnerships between banks and fintech firms and results in knowledge transfer from fintech firms to banks. Both banks and fintech startup firms benefit from their investment relationships and the subsequent partnerships. Banks leverage the startup firms' technologies and gain knowledge spillover, while fintech firms receive financial investments and additional business from banks and their customers.

6 Discussion

Navigating fintech challenges is critically important for the survival and success of incumbent banks. Internally, they increase investments in information technologies and AI-related human capital (Vives and Ye, 2021; Jiang et al., 2022b, Jiang et al., 2021). Externally, as we show, they make financial investments in fintech startup firms, collaborate

with them, and utilize their technologies. In theory, banks can collaborate with fintech startups without making any financial investment. However, our study demonstrates that financial investment is a key conduit for business collaboration. Business collaborations rarely (only 2% among pseudo bank investors and fintech investees) happen between a large incumbent bank and a fintech firm without financial investment.[22] Therefore, venture investment plays an important role in building relationships and trust between the two parties, who are potential competitors.

Another natural means to overcome potential property rights breaches and for banks to obtain technology from a fintech firm is to buy the entire startup company. Interestingly, our investigation reveals that banks rarely make such acquisitions, in contrast to their frequent merger-and-acquisition activities with other banks.[23]

Instead, they make minority investments, build relationships, and form partnerships. It is perhaps not surprising that both banks and fintech firms shun mergers, considering that banks are highly regulated, whereas fintechs have relatively less regulatory requirements. Bank regulations are costly and can hinder a fintech startup's growth by restricting their freedom and speed in undertaking new projects (see reports by Skadden and KPMG).[24]

7 Conclusions

We document a rapidly increasing trend over the last twenty years of banks making investments in fintech startups. In contrast to prior studies that document banks make venture

[22]For small community banks, there exists a different type of collaboration with fintech firms, where the fintech company interacts directly with and serves as the main point of contact for end customers while the bank provides the back-end banking services. As we discussed earlier, small community banks do not typically engage in venture investments and are not the focus of this paper.

[23]During our sample period of 2001-2022, banks acquired only 40 fintech startups. Of these, 12 had previously received bank investment. In the same period, 651 other fintech startups were acquired by non-banking firms.

[24]For more details of the Skadden and KPMG reports, please see https://www.skadden.com/insights/publications/2021/06/the-informed-board/fintech-disruption and https://kpmg.com/kpmg-us/content/dam/kpmg/pdf/2022/how-banks-maximize-value-fintech-acquisitions.pdf.

investments to build lending relationships, we find that the strategic focus of banks' venture investments has changed. Banks have increasingly utilized such investments as a solution to their fintech challenge. Consistent with our hypothesis, we find that banks are more likely to invest in fintech startup firms when facing greater fintech competition. They are also more likely to invest in startups that have business or technological relatedness with them. Specifically, they are more likely to invest in startup firms if they operate in similar business areas, have higher technological overlap, or cite each other's patents.

Using an instrumental variable analysis, we also find evidence that banks' financial investments in fintech startups have impacts on the two firms' operations and innovations. First, we find a strikingly higher likelihood of business partnerships between a bank and a fintech startup after the bank invests in the startup. The partnerships involve the bank utilizing the startup's technology or the two firms cross-selling to each other's customers. Second, the two firms' post-investment patents tend to have greater cross-citations, suggesting that venture investments also facilitate knowledge transfer.

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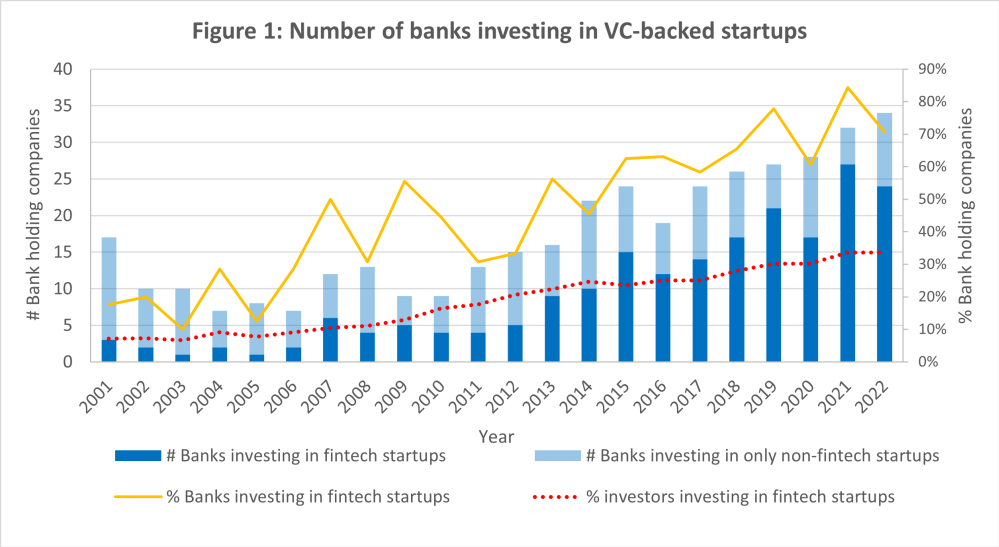


Figure 1 plots the number of banks making new investments in VC-backed fintech and non-fintech startups in the U.S. between 2001 and 2022. The dark (light) blue histogram represents the number of banks making new investments in fintech (non-fintech) startups. The yellow (red dotted) line represents the percentage of banks (all investors) making new investments in fintech startups.

Figure 1: **Number of banks investing in VC-backed startups over time**

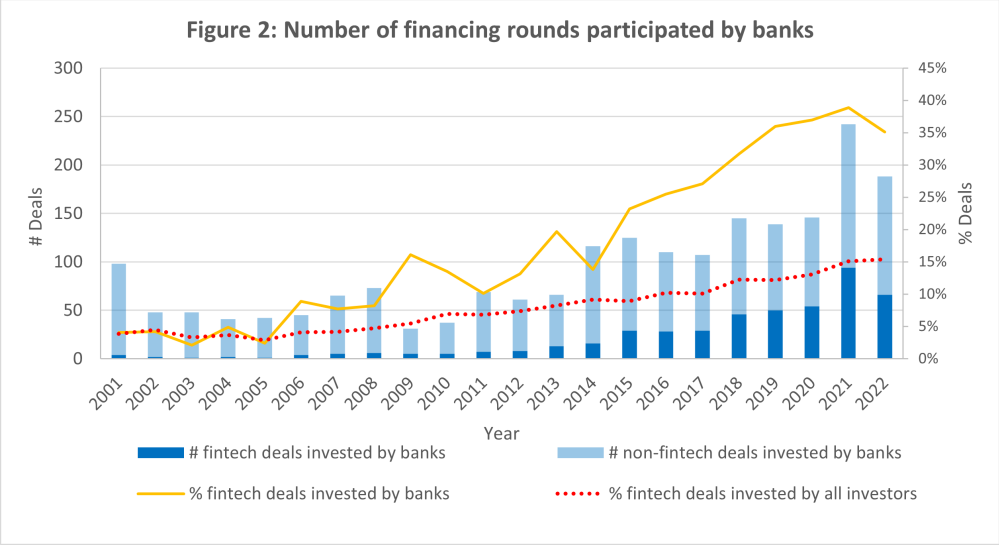


Figure 2 plots the number of investment deals invested in VC-backed fintech and non-fintech startups by banks in the U.S. between 2001 and 2022. The dark (light) blue histogram represents the number of fintech (non-fintech) deals participated by banks. The yellow (red dotted) line represents the percentage of fintech deals by banks (all investors).

Figure 2: **Number of financing rounds participated by banks**

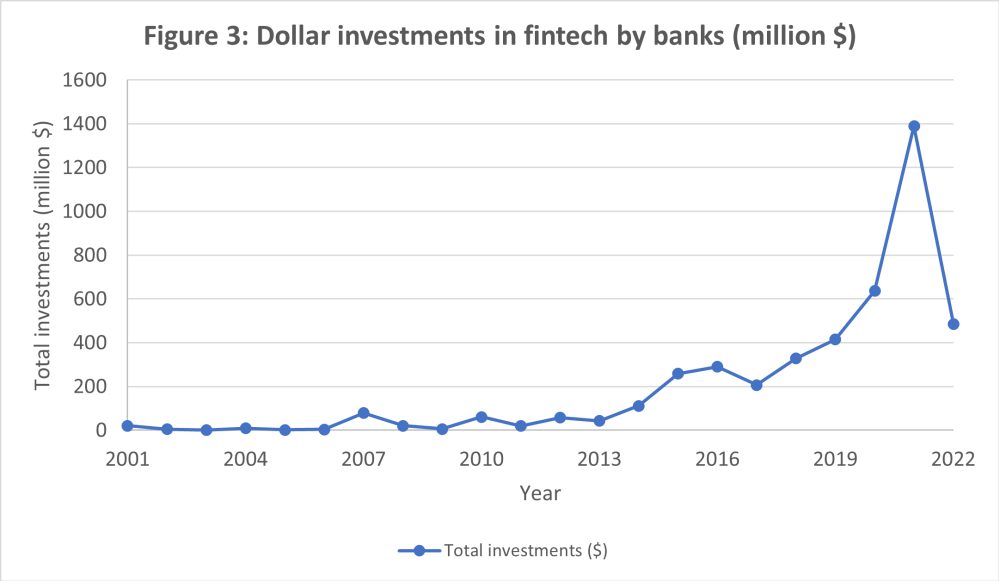


Figure 3 plots the dollar investments in VC-backed fintech startups by banks in the U.S. between 2001 and 2022. We assume equal investments by each investor for deals with multiple investors.

Figure 3: **Dollar investments in fintech by banks (million $)**

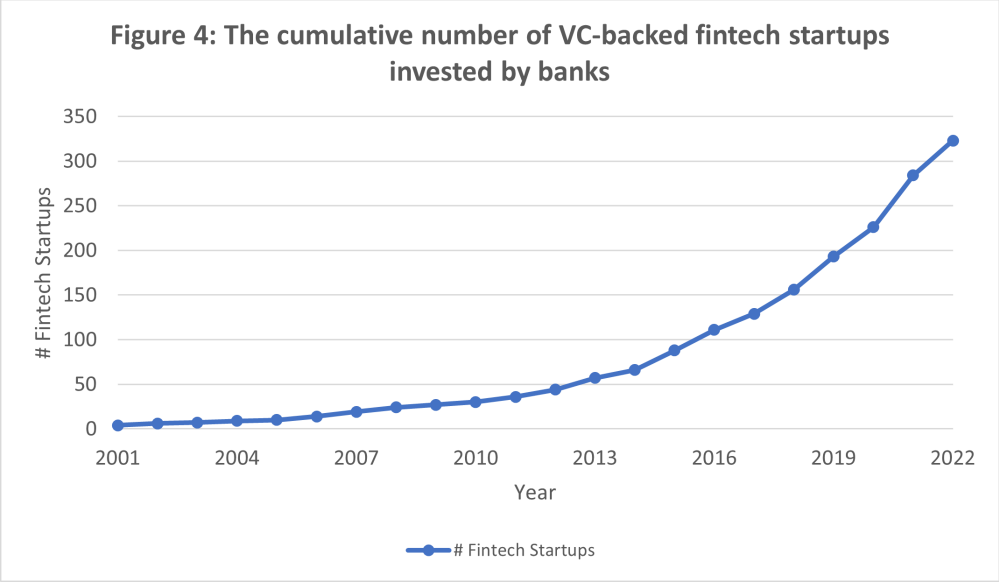
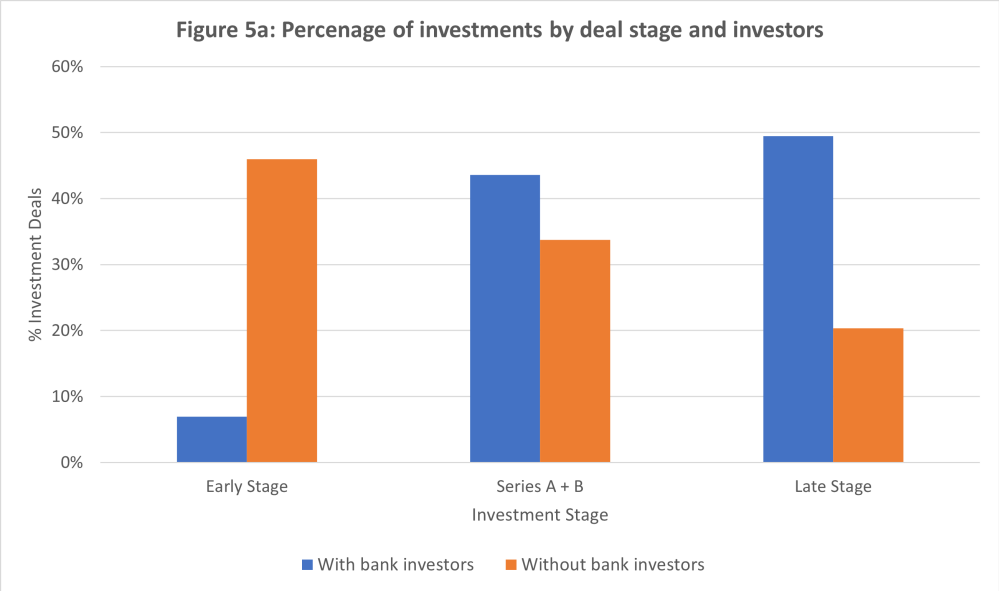


Figure 4 plots the cumulative number of VC-backed fintech startups invested by banks in the U.S. between 2001 and 2022.

Figure 4: **The cumulative number of fintech startups invested by banks**



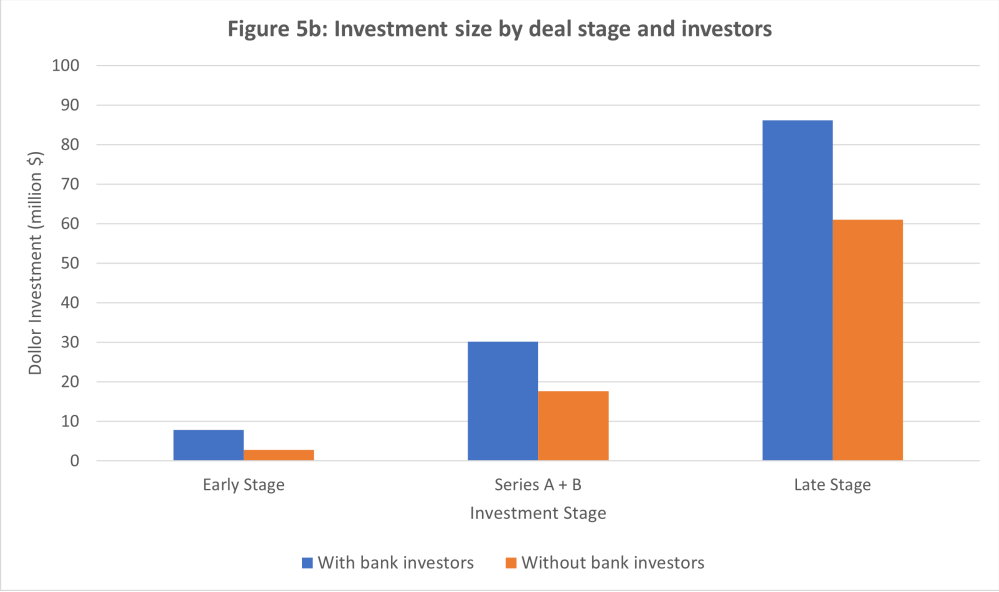


Figure 5a plots the percentage of VC-backed fintech startup financing deals by different deal stages in the U.S. between 2001 and 2022. The blue histogram represents the percentage of fintech deals with banks, while the orange histogram represents the percentage of fintech deals without banks. Early Stage deals consist of deals that are labeled as ANGEL ROUND, PRE SEED ROUND, and SEED ROUND in Crunchbase; Series A+B deals consist of deals that are labeled as SERIES A, and SERIES B in Crunchbase; Late Stage deals consist of deals that are labeled as SERIES C, SERIES D, SERIES E, SERIES F, SERIES G, SERIES H, PRIVATE EQUITY ROUND, and CORPORATE ROUND in Crunchbase. Figure 5b plots the dollar investments of VC-backed fintech startup financing deals by different deal stages in the U.S. between 2001 and 2022. The blue histogram represents the dollar amount of fintech deals with banks, while the orange histogram represents the dollar amount of fintech deals without banks.

Figure 5: **Investment stage and size**

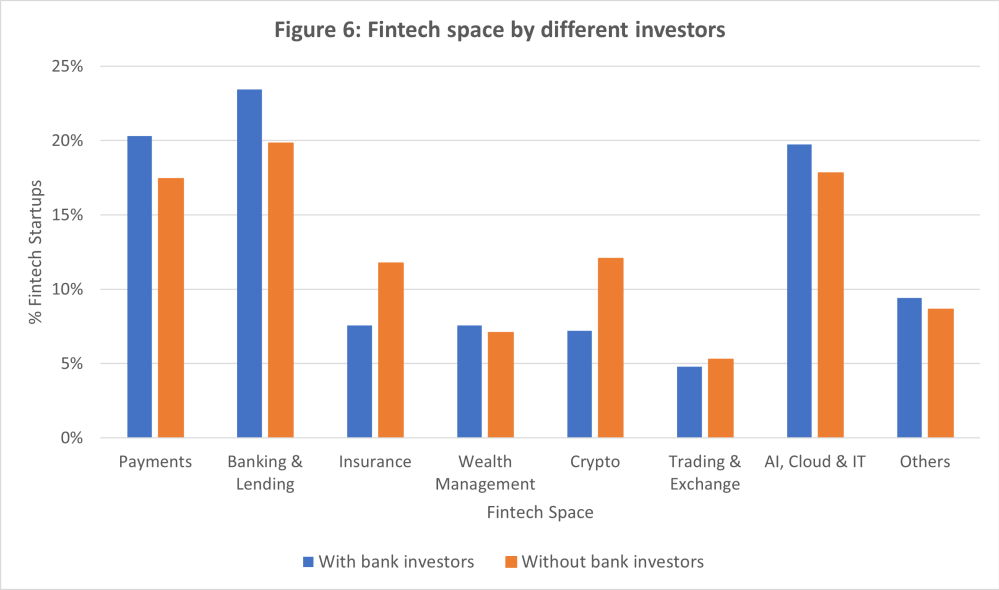


Figure 6 plots the percentage of fintech deals in different fintech spaces between 2001 and 2022. The blue histogram represents the percentage of deals with bank investors' participation, while the orange histogram represents the percentage of financing deals without bank investors' participation. Fintech startups are classified into different fintech spaces based on their industry category and business description in Crunchbase.

Figure 6: **Fintech space**

Table 1: **Summary statistics**

This table reports summary statistics of actual and pseudo deals at fintech round-bank level. Panel A reports summary statistics of fintech startup characteristics. Panel B reports summary statistics of bank investor characteristics. Panel C reports summary statistics of pre-deal bank-fintech pair characteristics. ***, **, and * indicate significance at the 1, 5, and 10 percent levels between actual deals and pseudo deals.Definitions of variables are provided in Table A.2 in the Appendix.

	Actual Deals	Random-matched Pseudo Deals	PSM Pseudo Deals
	Mean	Mean	Mean
Panel A: fintech startup characteristics (fintech round-bank level)			
Deal Size (Millions)	55.186	19.948***	31.944***
Startup Age (Months)	65.550	44.348***	60.208**
# New Patents [t-1]	0.550	0.219*	0.243*
Fintech Space: Payments	0.204	0.185	0.208
Fintech Space: Banking & Lending	0.315	0.226***	0.240***
Fintech Space: Insurance	0.072	0.157***	0.166***
Fintech Space: Wealth Management	0.094	0.083	0.087
Fintech Space: Crypto	0.086	0.139***	0.120**
Fintech Space: Trading & Exchange	0.047	0.064	0.061
Fintech Space: AI, Cloud & IT	0.223	0.201	0.190*
Fintech Space: Others	0.114	0.089***	0.075***
Observation	511	2555	2555
Panel B: bank characteristics (fintech round-bank level)			
# New Patents [t-1]	25.925	0.022***	2.696***
Total Asset (Millions) [t-1]	417,009	13,594***	63,382***
Ln(Total Asset) [t-1]	12.896	8.236***	10.178***
Sales Growth [t-1]	0.080	0.131***	0.121***
ROA [t-1]	0.013	0.010***	0.012**
Stock Return [t-1]	0.136	0.060***	0.052***
BM [t-1]	0.806	0.884***	0.836*
Fintech Competition (Weighted by County Branches)	0.238	0.195***	0.199***
Observation	511	2555	2555
Panel C: bank-fintech pair characteristics (fintech round-bank level)			
Overlap Business(#)	1.034	0.714***	0.745***
Overlap Business(%)	17.442	11.458***	11.851***
Technological Overlap	0.100	0.026***	0.048***
Cross Citation	0.030	0.003***	0.005***
Cross Citation by Bank	0.013	0.002***	0.003***
Cross Citation by Fintech	0.024	0.002***	0.004***
Observation	511	5110	5110

Table 2: **Likelihood of fintech investment by bank investors: Fintech Competition**

This table reports coefficient estimates from OLS regressions. Our fintech competition measure starts from 2009 and is matched to deals of 2010-2021. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. *Fintech Competition* is measured as the growth rate of the average fintech market share across counties a bank has a presence in weighted by its number of branches in each county. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 5 pseudo deals: We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Fintech Competition	0.047***	0.121***	0.058**
	(3.11)	(4.65)	(2.26)
Bank Size [t-1]	0.150***	0.195***	0.192***
	(41.86)	(52.50)	(38.01)
BM [t-1]	-0.065***	-0.079**	-0.098***
	(-3.00)	(-2.51)	(-2.92)
# New Patents: Bank [t-1]	0.200	-0.122	-0.110
	(1.49)	(-0.41)	(-0.47)
Sales Growth[t-1]	0.119***	0.112**	0.040
	(3.03)	(2.31)	(0.93)
ROA [t-1]	3.147***	7.216***	7.936***
	(3.29)	(4.63)	(5.12)
Stock Return [t-1]	-0.042**	0.151***	0.159***
	(-1.97)	(4.17)	(4.33)
Deal Group FE	No	Yes	Yes
Bank State FE	No	No	Yes
Number of observations	2883	2883	2883
Adjusted R^2	0.4263	0.4845	0.5725

Table 3: **Likelihood of fintech investment by bank investors: Technological Overlap**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable is our measure of technological overlap between fintech startups and banks. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Technological Overlap	0.058**	0.056**	0.054**
	(2.26)	(2.21)	(2.13)
Fintech startup characteristics			
# New Patents: Fintech [t-1]	0.840	1.060	1.037
	(0.67)	(0.83)	(0.80)
Ln(Age at Deal)	0.043***	0.039***	0.032***
	(6.43)	(5.59)	(4.32)
Ln(Deal Amount)	0.130***	0.130***	0.124***
	(28.23)	(27.41)	(22.77)
Fintech Space: Payments		-0.013	-0.013
		(-0.80)	(-0.81)
Fintech Space: Banking & Lending		0.028*	0.029*
		(1.86)	(1.93)
Fintech Space: Insurance		-0.072***	-0.072***
		(-3.70)	(-3.71)
Fintech Space: Wealth Management		-0.006	-0.005
		(-0.32)	(-0.27)
Fintech Space: Crypto		-0.028	-0.026
		(-1.36)	(-1.28)
Fintech Space: Trading & Exchange		-0.031	-0.031
		(-1.37)	(-1.36)
Fintech Space: AI, Cloud & IT		0.033	0.034
		(1.57)	(1.62)
Fintech Space: Others		0.054**	0.056**
		(2.32)	(2.39)
Bank investor characteristics			
# New Patents: Bank [t-1]	0.067	0.057	0.061
	(1.30)	(1.05)	(1.13)
Bank Size [t-1]	0.051***	0.055***	0.055***
	(23.44)	(23.70)	(23.82)
BM [t-1]	-0.019	-0.015	-0.016
	(-1.59)	(-1.29)	(-1.36)
Sales Growth[t-1]	0.060***	0.058***	0.058***
	(2.96)	(2.78)	(2.78)

ROA [t-1]	2.437***	2.540***	2.536***
	(3.76)	(3.70)	(3.69)
Stock Return [t-1]	0.083***	0.086***	0.085***
	(5.45)	(5.49)	(5.46)
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5606	5606	5606
Adjusted R^2	0.0898	0.0995	0.0882

Table 4: **Likelihood of fintech investment by bank investors: Cross Citation**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable in Panel A is our measure of cross citation between fintech startups and bank investors. The key independent variables in Panel B are our measures of cross citation from fintech startups to bank investors and cross citation from bank investors to fintech startups. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Panel A: Cross Citation

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation	0.213***	0.213***	0.213***
	(2.93)	(2.97)	(2.97)
Fintech startup characteristics			
# New Patents: Fintech [t-1]	0.315	0.523	0.487
	(0.24)	(0.39)	(0.36)
Ln(Age at Deal)	0.045***	0.040***	0.033***
	(6.63)	(5.79)	(4.44)
Ln(Deal Amount)	0.130***	0.129***	0.124***
	(28.22)	(27.45)	(22.71)
Fintech Space: Payments		-0.009	-0.009
		(-0.56)	(-0.57)
Fintech Space: Banking & Lending		0.031**	0.031**
		(2.05)	(2.12)
Fintech Space: Insurance		-0.069***	-0.069***
		(-3.56)	(-3.57)
Fintech Space: Wealth Management		-0.005	-0.004
		(-0.24)	(-0.20)
Fintech Space: Crypto		-0.024	-0.022
		(-1.16)	(-1.08)
Fintech Space: Trading & Exchange		-0.030	-0.030
		(-1.34)	(-1.32)
Fintech Space: AI, Cloud & IT		0.037*	0.038*
		(1.80)	(1.85)
Fintech Space: Others		0.058**	0.060**
		(2.49)	(2.56)
# New Patents: Bank [t-1]	0.064	0.053	0.057
	(1.21)	(0.96)	(1.04)
Bank investor characteristics			
Bank Size [t-1]	0.052***	0.055***	0.055***
	(24.22)	(24.45)	(24.55)
BM [t-1]	-0.020	-0.016	-0.017
	(-1.63)	(-1.33)	(-1.40)

Sales Growth[t-1]	0.057***	0.055***	0.055***
	(2.80)	(2.63)	(2.63)
ROA [t-1]	2.520***	2.623***	2.617***
	(3.86)	(3.78)	(3.77)
Stock Return [t-1]	0.080***	0.084***	0.083***
	(5.23)	(5.27)	(5.24)
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5606	5606	5606
Adjusted R^2	0.0922	0.1020	0.0908

Panel B: Cross Citation with Directions

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation by Bank	0.066	0.065	0.066
	(0.67)	(0.68)	(0.69)
Cross Citation by Fintech	0.237***	0.237***	0.236***
	(2.64)	(2.67)	(2.67)
Fintech startup characteristics			
# New Patents: Fintech [t-1]	0.017	0.233	0.197
	(0.01)	(0.17)	(0.15)
Ln(Age at Deal)	0.045***	0.041***	0.034***
	(6.69)	(5.86)	(4.51)
Ln(Deal Amount)	0.130***	0.129***	0.124***
	(28.31)	(27.51)	(22.77)
Fintech Space: Payments		-0.010	-0.010
		(-0.59)	(-0.60)
Fintech Space: Banking & Lending		0.030**	0.031**
		(2.04)	(2.10)
Fintech Space: Insurance		-0.068***	-0.068***
		(-3.55)	(-3.56)
Fintech Space: Wealth Management		-0.005	-0.004
		(-0.24)	(-0.19)
Fintech Space: Crypto		-0.024	-0.022
		(-1.17)	(-1.08)
Fintech Space: Trading & Exchange		-0.031	-0.030
		(-1.34)	(-1.32)
Fintech Space: AI, Cloud & IT		0.037*	0.038*
		(1.79)	(1.84)
Fintech Space: Others		0.058**	0.060**
		(2.50)	(2.57)
Bank investor characteristics			
# New Patents: Bank [t-1]	0.066	0.056	0.059
	(1.23)	(0.99)	(1.07)
Bank Size [t-1]	0.052***	0.055***	0.056***
	(24.15)	(24.40)	(24.49)
BM [t-1]	-0.020*	-0.017	-0.018

	(-1.70)	(-1.40)	(-1.46)
Sales Growth[t-1]	0.058***	0.056***	0.056***
	(2.87)	(2.71)	(2.71)
ROA [t-1]	2.488***	2.592***	2.586***
	(3.83)	(3.76)	(3.75)
Stock Return [t-1]	0.079***	0.082***	0.082***
	(5.08)	(5.12)	(5.09)
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5606	5606	5606
Adjusted R^2	0.0924	0.1022	0.0910

Table 5: **Likelihood of fintech investment by bank investors: Overlap Business**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable in Panel A is the number of industries both the bank investor and the fintech startup have businesses. The key independent variable in Panel B is the percentage of industries both the bank investor and the fintech startup have businesses. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo bank investors in Crunchbase. We then select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Panel A: Overlap Business (#)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(#)	0.044***	0.040***	0.039***
	(5.19)	(4.65)	(4.61)
Fintech startup characteristics			
# New Patents: Fintech [t-1]	1.690	1.833	1.783
	(1.20)	(1.30)	(1.26)
Ln(Age at Deal)	0.041***	0.037***	0.032***
	(4.75)	(4.12)	(3.32)
Ln(Deal Amount)	0.145***	0.145***	0.141***
	(25.88)	(25.47)	(20.85)
Fintech Space: Payments		-0.011	-0.011
		(-0.48)	(-0.48)
Fintech Space: Banking & Lending		0.017	0.017
		(0.81)	(0.84)
Fintech Space: Insurance		-0.069***	-0.068***
		(-2.86)	(-2.82)
Fintech Space: Wealth Management		-0.012	-0.012
		(-0.46)	(-0.43)
Fintech Space: Crypto		-0.004	-0.004
		(-0.14)	(-0.13)
Fintech Space: Trading & Exchange		-0.047	-0.047
		(-1.62)	(-1.64)
Fintech Space: AI, Cloud & IT		0.050*	0.051*
		(1.79)	(1.81)
Fintech Space: Others		0.068**	0.069**
		(2.10)	(2.12)
Bank investor characteristics			
# New Patents: Bank [t-1]	-0.710**	-0.675**	-0.664**
	(-2.43)	(-2.32)	(-2.28)
Bank Size [t-1]	0.055***	0.057***	0.057***
	(9.75)	(9.73)	(9.70)
BM [t-1]	-0.068***	-0.068***	-0.069***

	(-2.73)	(-2.71)	(-2.74)
Sales Growth[t-1]	0.047	0.046	0.046
	(1.26)	(1.22)	(1.22)
ROA [t-1]	3.282**	3.475**	3.486**
	(2.41)	(2.46)	(2.48)
Stock Return [t-1]	0.063**	0.060**	0.061**
	(2.38)	(2.23)	(2.26)
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3491	3491	3491
Adjusted R^2	0.1003	0.1095	0.0903

Panel B: Overlap Business (%)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(%)	0.003***	0.003***	0.003***
	(6.43)	(5.83)	(5.79)
Fintech startup characteristics			
# New Patents: Fintech [t-1]	1.728	1.833	1.783
	(1.22)	(1.30)	(1.25)
Ln(Age at Deal)	0.042***	0.038***	0.033***
	(4.91)	(4.25)	(3.45)
Ln(Deal Amount)	0.143***	0.143***	0.140***
	(25.32)	(25.07)	(20.59)
Fintech Space: Payments		-0.007	-0.008
		(-0.34)	(-0.35)
Fintech Space: Banking & Lending		0.014	0.015
		(0.70)	(0.73)
Fintech Space: Insurance		-0.064***	-0.063***
		(-2.68)	(-2.65)
Fintech Space: Wealth Management		-0.013	-0.012
		(-0.49)	(-0.46)
Fintech Space: Crypto		-0.001	-0.001
		(-0.05)	(-0.04)
Fintech Space: Trading & Exchange		-0.044	-0.044
		(-1.51)	(-1.54)
Fintech Space: AI, Cloud & IT		0.054*	0.055**
		(1.96)	(1.98)
Fintech Space: Others		0.061*	0.062*
		(1.89)	(1.91)
# New Patents: Bank [t-1]	-0.708**	-0.673**	-0.663**
	(-2.43)	(-2.32)	(-2.29)
Bank investor characteristics			
Bank Size [t-1]	0.057***	0.059***	0.059***
	(9.84)	(9.87)	(9.83)
BM [t-1]	-0.075***	-0.075***	-0.075***
	(-2.96)	(-2.92)	(-2.95)

Sales Growth[t-1]	0.051	0.050	0.049
	(1.32)	(1.27)	(1.27)
ROA [t-1]	3.226**	3.431**	3.443**
	(2.39)	(2.45)	(2.47)
Stock Return [t-1]	0.064**	0.061**	0.061**
	(2.40)	(2.25)	(2.27)
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3491	3491	3491
Adjusted R^2	0.1048	0.1131	0.0940

Table 6: **Summary statistics for Fintech-Bank Partnership**

This table reports summary statistics of fintech startup-bank investor partnerships. Our sample of investment deals starts from 2001 to 2021. We exclude a small number of observations where the timing information of the business partnership is not available. Definitions of all variables are provided in Table A.2 in the Appendix.

Panel A: Summary statistics

	N	Mean	Min.	Median	Max.	S.D.
Treated sample						
Bank-Fintech Partnership	314	0.296	0	0	1	0.457
Post-investment Fintech-Bank Partnership						
– All	314	0.274	0	0	1	0.447
– Utilize Fintech Technology	314	0.131	0	0	1	0.337
– Cross Sell to Bank Customers	314	0.105	0	0	1	0.307
– Cross Sell to Fintech Customers	314	0.070	0	0	1	0.256
Control sample						
Bank-Fintech Partnership	3,273	0.017	0	0	1	0.131
Post-investment Fintech-Bank Partnership						
– All	3,273	0.015	0	0	1	0.123
– Utilize Fintech Technology	3,273	0.008	0	0	1	0.087
– Cross Sell to Bank Customers	3,273	0.004	0	0	1	0.060
– Cross Sell to Fintech Customers	3,273	0.004	0	0	1	0.063

Panel B: Summary statistics by fintech space (Treated sample)

	Post-investment Fintech-Bank Partnership				
	All	Utilize Fintech Technology	Cross Sell to Bank Customers	Cross Sell to Fintech Customers	Obs
Payments	0.261	0.058	0.116	0.087	69
Banking & Lending	0.269	0.097	0.118	0.108	93
Insurance	0.125	0.042	0.000	0.083	24
Wealth Management	0.240	0.080	0.120	0.080	25
Trading & Exchange	0.063	0.063	0.000	0.000	16
Crypto	0.318	0.273	0.045	0.045	22
AI, Cloud & IT	0.351	0.243	0.095	0.054	74
Others	0.281	0.063	0.125	0.094	32

Table 8: **Post-investment Partnership**

This table reports coefficient estimates from 2SLS regressions. Our sample of investment deals starts from 2001 to 2021. The dependent variable in Column (1) is a dummy variable that equals one if the bank-fintech forms any partnership apart from the investment relationship. The dependent variable in Column (2) is a dummy variable that equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the bank investor utilizes the technology from the fintech startup. The dependent variable in Column (3) is a dummy variable that equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the fintech startup cross-sells its products to the customers of the bank investor. The dependent variable in Column (4) is a dummy variable that equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the bank investor cross-sells its products to the customers of the fintech startup, and zero otherwise. The key independent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The instrumental variable, *% VC Deals in Local CBSA [t-1]* is the percentage of VC deals participated by the bank investor in local CBSA before the focal fintech deal. Controls consist of fintech space dummies and one-year lagged variables: *# New Patents: Fintech*, *Ln(Deal Amount)*, *Ln(Age at Deal)*, *# New Patents: Bank Investor*, *Bank Size*, *BM [t-1]*, *Sales Growth*, *ROA*, and *Stock Return*. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each startup-investor pair, we pick only the first investment deal. For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Dependent Variable	Actual Investment	Post-investment Fintech-Bank Partnership			
	1st-stage	All	Utilize Fintech Technology	Cross Sell to Bank Customers	Cross Sell to Fintech Customers
	(1)	(2)	(3)	(4)	(5)
% VC Deals in Local CBSA [t-1]	10.553***				
	(4.74)				
Instrumented Actual Investment		0.447**	0.398**	0.084*	-0.004
		(2.43)	(2.18)	(1.88)	(-0.08)
Controls	Yes	Yes	Yes	Yes	Yes
Fintech Space Dummies	Yes	Yes	Yes	Yes	Yes
Deal Group FE	Yes	Yes	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes	Yes	Yes
Deal Stage FE	Yes	Yes	Yes	Yes	Yes
Number of observations	3557	3557	3557	3557	3557
Adjusted R^2	0.0739	0.0280	0.0205	0.0056	0.0073
Kleibergen-Paap F-test	22.43				

Table 9: **Post-investment Cross Citation**

This table reports coefficient estimates from the 2nd-stage regressions of 2SLS regressions. Our sample of investment deals starts from 2001 to 2021. The dependent variable in Column (1) is our measure of post-deal cross citation between fintech startups and bank investors. It is a dummy variable that equals one if any patents granted to the bank investor have cited any patents from the fintech startup since the investment year or any patents granted to the fintech startup have cited any patents from the bank investor since the investment year. The dependent variable in Column (2) is our measure of post-deal cross citation from fintech startups to bank investors. It is a dummy variable that equals one if any patents granted to the fintech startup have cited any patents from the bank investor since the investment year. The dependent variable in Column (3) is our measure of post-deal cross citation from bank investors to fintech startups. It is a dummy variable that equals one if any patents granted to the bank investor have cited patents from the fintech startup since the investment year. The key independent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The instrumental variable, *% VC Deals in Local CBSA [t-1]* is the percentage of VC deals participated by the bank investor in local CBSA before the focal fintech deal. Controls consist of fintech space dummies and one-year lagged variables: *# New Patents: Fintech*, *Ln(Deal Amount)*, *Ln(Age at Deal)*, *# New Patents: Bank Investor*, *Bank Size*, *BM [t-1]*, *Sales Growth*, *ROA*, and *Stock Return*. Definitions of all independent variables are provided in Table A.2 in the Appendix. We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each startup-investor pair, we pick only the first investment deal. For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Dependent Variable	Post-investment Cross Citation		
	Cross Citation	Cross Citation by Fintech	Cross Citation by Bank
	(1)	(2)	(3)
Instrumented Actual Investment	0.148**	0.082	0.147**
	(2.15)	(1.11)	(2.20)
Cross Citation [t-1]	0.187***		
	(3.20)		
Cross Citation by Fintech [t-1]		0.241***	
		(3.62)	
Cross Citation by Bank [t-1]			0.255**
			(2.58)
Controls	Yes	Yes	Yes
Fintech Space Dummies	Yes	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	Yes	Yes	Yes
Number of observations	3572	3572	3572
Adjusted R^2	0.1884	0.2069	0.2173

Appendix

Table A.1: **Banks investing in fintech startups**

This table lists all 51 banks that have ever invested in a VC-backed fintech startup from 2001 to 2022.

Name	
1ST SOURCE CORP	JPMORGAN CHASE & CO
ACCESS NATIONAL CORP	KEYCORP
ALLY FINANCIAL INC	KEYSTONE FINANCIAL INC
AMERANT BANCORP INC	LIVE OAK BANCSHARES INC
AMERICAN EXPRESS CO	META FINANCIAL GROUP INC
ATLANTIC UNION BANKSHRS CRP	MORGAN STANLEY
BANC OF CALIFORNIA INC	MVB FINANCIAL CORP
BANK OF AMERICA CORP	NATIONAL BANK HLDGS CORP
BANK OF NEW YORK MELLON CORP	PACWEST BANCORP
CAPITAL ONE FINANCIAL CORP	PINNACLE FINL PARTNERS INC
CITIGROUP INC	PNC FINANCIAL SVCS GROUP INC
CITIZENS FINANCIAL GROUP INC	PROVIDENT BANCORP INC
CITY NATIONAL CORP	RAYMOND JAMES FINANCIAL CORP
COASTAL FINANCIAL CORP	REGIONS FINANCIAL CORP
COMERICA INC	STATE STREET CORP
DIME COMMUNITY BANCSHARES	STIFEL FINANCIAL CORP
DISCOVER FINANCIAL SVCS	SUNTRUST BANKS INC
EAST WEST BANCORP INC	SUSQUEHANNA BANCSHARES INC
ENCORE BANCSHARES INC	SVB FINANCIAL GROUP
FIFTH THIRD BANCORP	UMB FINANCIAL CORP
FIRST FOUNDATION INC	US BANCORP
FIRST REPUBLIC BANK	WEBSTER FINANCIAL CORP
GOLDMAN SACHS GROUP INC	WELLS FARGO & CO
GREENPOINT FINANCIAL CORP	WINTRUST FINANCIAL CORP
IMPERIAL CAPITAL BANCORP INC	ZIONS BANCORPORATION NA
IRWIN FINANCIAL CORP	

Table A.2: **Variable definition**

Variable	Definition
Fintech startup characteristics	
# New Patents: Fintech	The number of new patents filed by the fintech startup in a given year.
Ln(Age at Deal)	The natural logarithm of the fintech startup's age at the investment date measured in months.
Ln(Deal Amount)	The natural logarithm of the amount in a given deal.
Fintech Space: Payments	A dummy variable equals one if the fintech startup's business description contains the following keywords: PAYMENT; or it has businesses in the following sectors: PAYMENTS, MOBILE PAYMENTS.
Fintech Space: Banking & Lending	A dummy variable equals one if the fintech startup's business description contains the following keywords: BANK, LEND, FINANCING, LOAN, CREDIT; or it has businesses in the following sectors: BANKING, LENDING, FINANCING, CREDIT.
Fintech Space: Insurance	A dummy variable equals one if the fintech startup's business description contains the following keywords: INSURANCE; or it has businesses in the following sectors: INSURANCE, INSURTECH.
Fintech Space: Wealth Management	A dummy variable equals one if the fintech startup's business description contains the following keywords: MONEY MANAGEMENT, INVESTMENT; or it has businesses in the following sectors: WEALTH MANAGEMENT, ASSET MANAGEMENT.
Fintech Space: Crypto	A dummy variable equals one if the fintech startup's business description contains the following keywords: CRYPTO, BITCOIN, VIRTUAL CURRENCY; or it has businesses in the following sectors: CRYPTOCURRENCY, BITCOIN, VIRTUAL CURRENCY.
Fintech Space: Trading & Exchange	A dummy variable equals one if the fintech startup's business description contains the following keywords: FINANCIAL EXCHANGE, STOCK EXCHANGE, TRADING; or it has businesses in the following sectors: FINANCIAL EXCHANGE, STOCK EXCHANGE, TRADING PLATFORM.
Fintech Space: AI, Cloud & IT	A dummy variable equals one if the fintech startup does not belong above sectors and has businesses in the following sectors: CLOUD, NATURAL LANGUAGE PROCESSING, ARTIFICIAL INTELLIGENCE, BIG DATA, INTERNET, SOFTWARE; or it has businesses in the following sector groups: ARTIFICIAL INTELLIGENCE, DATA AND ANALYTICS, INFORMATION TECHNOLOGY.
Fintech Space: Others	A dummy variable equals one if the fintech startup does not belong to the above sectors.

Deal Stage	We classify each deal into the following three stages: early stage, series A&B, and late stage. Early Stage deals consist of deals that are labeled as ANGEL ROUND, PRE SEED ROUND, and SEED ROUND in Crunchbase; Series A&B deals consist of deals that are labeled as SERIES A, and SERIES B in Crunchbase; Late Stage deals consist of deals that are labeled as SERIES C, SERIES D, SERIES E, SERIES F, SERIES G, SERIES H, PRIVATE EQUITY ROUND, and CORPORATE ROUND in Crunchbase.
Bank investor characteristics	
Fintech Competition	The growth rate of the average fintech market share across counties a bank has presence in weighted by its number of branches in each county. We use mortgage loan data for first-lien and 1-4 family homes from HMDA to calculate the market share for each lender. To classify fintech lenders, we use the list of ten fintech lenders from Jagtiani et al. (2021) and Berg et al. (2022).
# New Patents: Bank	The number of new patents filed by the bank investor in a given year.
Bank Size	The natural logarithm of a bank's total assets.
BM	The book value of common equity scaled by the market value of common equity.
Sales Growth	The growth rate of sales.
ROA	Net income scaled by total assets in millions of dollars.
Stock Return	The quarter return equals the year-end closing price minus the prior year-end closing price divided by the prior year-end closing price.
% VC Deals in Local CBSA	The percentage of VC deals participated by the bank investor in local CBSA before the focal fintech deal.
Fintech startup-bank investor pair characteristics	
Technological Overlap	Following Jaffe (1986) and Bena and Li (2014), the technological overlap is computed as $\frac{S_{fintech}S'_{bank}}{\sqrt{S_{fintech}S'_{fintech}}\sqrt{S_{bank}S'_{bank}}}$, where the vector $S_{fintech} = (S_{fintech,1}, ..., S_{fintech,K})$ captures the innovation activities for the fintech startup and $k \in (1, K)$ is the technology class index. $S_{fintech,k}$ is the ratio of the number of patents granted to the fintech startup in technology class k before the investment year to the total number of patents granted to the fintech startup in all technology classes over the same period. Similarly, $S_{bank} = (S_{bank,1}, ..., S_{bank,K})$ captures the innovation activities for the bank investor. $S_{bank,k}$ is the ratio of the number of patents granted to the bank investor in technology class k before the investment year to the total number of patents granted to the bank investor in all technology classes over the same period.

Cross Citation	A dummy variable equals one if either any patents granted to the bank investor before the investment year have cited any patents from the fintech startup before the investment year, or any patents granted to the fintech startup have cited any patents from the bank investor before the investment year, and zero otherwise.
Cross Citation by Bank	A dummy variable equals one if any patents granted to the bank investor have cited any patents from the fintech startup before the investment year.
Cross Citation by Fintech	A dummy variable equals one if any patents granted to the fintech startup have cited any patents from the bank investor, and zero otherwise.
Overlap Business(#)	The number of industries both the bank investor and the fintech startup have businesses.
Overlap Business(%)	The percentage of industries both the bank investor and the fintech startup have businesses.
Post-investment Cross Citation	A dummy indicates equals one if any patents granted to the bank investor since the investment year have cited any patents from the fintech startup or any patents granted to the fintech startup have cited any patents from the bank investor since the investment year, and zero otherwise.
Post-investment Cross Citation by Bank	A dummy variable equals one if any patents granted to the bank investor have cited patents from the fintech startup since the investment year.
Post-investment Cross Citation by Fintech	A dummy variable equals one if any patents granted to the fintech startup have cited any patents from the bank investor since the investment year.
Fintech startup-bank investor partnership	
Fintech-Bank Partnership	A dummy variable equals one if a fintech startup and its bank investor have ever formed a partnership apart from the investment relationship, and zero otherwise.
Fintech-Bank Partnership: Utilize Fintech Technology	A dummy variable equals one if a fintech startup and its bank investor have ever formed a partnership that the bank investor utilizes the technology from the fintech startup, and zero otherwise.
Fintech-Bank Partnership: Cross Sell to Bank Customers	A dummy variable equals one if a fintech startup and its bank investor have ever formed a partnership that the fintech startup cross-sells its products to the customers of the bank investor, and zero otherwise.
Fintech-Bank Partnership: Cross Sell to Fintech Customers	A dummy variable equals one if a fintech startup and its bank investor have ever formed a partnership that the bank investor cross-sells its products to the customers of the fintech startup, and zero otherwise.
Post-investment Fintech-Bank Partnership	A dummy variable equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship, and zero otherwise.

Post-investment Fintech-Bank Partnership: Utilize Fintech Technology	A dummy variable equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the bank investor utilizes the technology from the fintech startup, and zero otherwise.
Post-investment Fintech-Bank Partnership: Cross Sell to Bank Customers	A dummy variable equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the fintech startup cross-sells its products to the customers of the bank investor, and zero otherwise.
Post-investment Fintech-Bank Partnership: Cross Sell to Fintech Customers	A dummy variable equals one if a fintech startup and its bank investor have formed a partnership since the investment relationship that the bank investor cross-sells its products to the customers of the fintech startup, and zero otherwise.

Internet Appendix

Table IA.1: **Likelihood of fintech investment by bank investors: Fintech Competition (Random-matched sample)**

This table reports coefficient estimates from OLS regressions. Our fintech competition sample starts from 2008 to 2021, as the fintech mortgage data in HMDA starts from 2008. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. *Fintech Competition* is computed as the growth rate of market share of mortgage loan amount originated by fintech lenders weighted by the number of branches in each county for the bank investor in the year before the investment. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 5 pseudo deals: We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors randomly.

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Fintech Competition	0.097***	0.167***	0.091***
	(5.99)	(5.99)	(3.53)
Bank Size [t-1]	0.121***	0.129***	0.116***
	(56.41)	(67.17)	(30.56)
BM [t-1]	0.058***	0.086***	0.028*
	(3.64)	(4.97)	(1.75)
# New Patents: Bank [t-1]	1.061***	1.041***	0.925***
	(7.62)	(4.25)	(4.57)
Sales Growth[t-1]	-0.157***	-0.173***	-0.038
	(-4.55)	(-4.03)	(-0.94)
ROA [t-1]	0.682	1.379	0.390
	(0.90)	(1.35)	(0.38)
Stock Return [t-1]	0.065***	0.125***	0.108***
	(3.76)	(4.35)	(3.76)
Deal Group FE	No	Yes	Yes
Bank State FE	No	No	Yes
Number of observations	2747	2747	2747
Adjusted R^2	0.6068	0.5891	0.6728

Table IA.2: **Likelihood of fintech investment by bank investors: Technological Overlap (Random-matched sample)**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable is our measure of technological overlap between fintech startups and banks. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms randomly. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors randomly.

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Technological Overlap	0.089**	0.084**	0.072*
	(2.08)	(1.98)	(1.70)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5479	5479	5479
Adjusted R^2	0.1246	0.1351	0.0860

Table IA.3: **Likelihood of fintech investment by bank investors: Cross Citation (Random-matched sample)**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable in Panel A is our measure of cross citation between fintech startups and bank investors. The key independent variables in Panel B are our measures of cross citation from fintech startups to bank investors and cross citation from bank investors to fintech startups. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms randomly. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors randomly.

Panel A: Cross Citation

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation	0.283***	0.277***	0.275***
	(2.97)	(2.95)	(2.95)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5479	5479	5479
Adjusted R^2	0.1274	0.1380	0.0894

Panel B: Cross Citation with Directions

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation by Investors	0.155	0.155	0.150
	(1.08)	(1.11)	(1.09)
Cross Citation by Fintech	0.264**	0.256**	0.255**
	(2.12)	(2.07)	(2.09)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5479	5479	5479
Adjusted R^2	0.1274	0.1379	0.0893

Table IA.4: **Likelihood of fintech investment by bank investors: Overlap Business (Random-matched sample)**

This table reports coefficient estimates from OLS regressions. Our sample of investment deals starts from 2001 to 2022. The dependent variable is a dummy variable that equals to one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. The key independent variable in Panel A is the number of industries both the bank investor and the fintech startup have businesses. The key independent variable in Panel B is the percentage of industries both the bank investor and the fintech startup have businesses. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms randomly. (2) We match the actual fintech startup with 5 pseudo banks from Compustat. We select the pseudo investors randomly.

Panel A: Overlap Business (#)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(#)	0.041***	0.036***	0.036***
	(5.43)	(4.67)	(4.59)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3701	3701	3701
Adjusted R^2	0.1141	0.1215	0.0558

Panel B: Overlap Business (%)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(%)	0.003***	0.002***	0.002***
	(6.27)	(5.30)	(5.26)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3701	3701	3701
Adjusted R^2	0.1171	0.1236	0.0580

Table IA.5: **Likelihood of fintech investment by bank investors: Technological Overlap and Fintech Comepetition**

This table reports coefficient estimates from OLS regressions. Our fintech competition measure starts from 2009 and is matched to deals of 2010-2021. The dependent variable is a dummy variable that equals to one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. *Fintech Competition* is measured as the growth rate of the average fintech market share across counties a bank has presence in weighted by its number of branches in each county. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Technological Overlap	0.062**	0.060**	0.057**
	(2.13)	(2.06)	(1.97)
Fintech Competition	0.031***	0.030***	0.032***
	(3.13)	(2.99)	(3.08)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5255	5255	5255
Adjusted R^2	0.0938	0.1039	0.0916

Table IA.6: **Likelihood of fintech investment by bank investors: Cross Citation and Fintech Comepetition**

This table reports coefficient estimates from OLS regressions. Our fintech competition measure starts from 2009 and is matched to deals of 2010-2021. The dependent variable is a dummy variable that equals to one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. *Fintech Competition* is measured as the growth rate of the average fintech market share across counties a bank has presence in weighted by its number of branches in each county. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo bank investors from Compustat. We select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Panel A: Cross Citation

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation	0.321***	0.317***	0.318***
	(2.92)	(2.94)	(2.96)
Fintech Competition	0.028***	0.027***	0.029***
	(2.78)	(2.64)	(2.75)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5305	5305	5305
Adjusted R^2	0.0966	0.1067	0.0946

Panel B: Cross Citation with Directions

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Cross Citation by Investors	0.253*	0.240*	0.241*
	(1.75)	(1.69)	(1.70)
Cross Citation by Fintech	0.235*	0.238*	0.241*
	(1.68)	(1.74)	(1.77)
Fintech Competition	0.029***	0.028***	0.029***
	(2.86)	(2.71)	(2.83)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	5305	5305	5305
Adjusted R^2	0.0960	0.1061	0.0940

Table IA.7: **Likelihood of fintech investment by bank investors: Overlap Business and Fintech Comepetition**

This table reports coefficient estimates from OLS regressions. Our fintech competition measure starts from 2009 and is matched to deals of 2010-2021. The dependent variable is a dummy variable that equals to one for the actual deal (the actual fintech-bank pair) and zero for matched pseudo deals. *Fintech Competition* is measured as the growth rate of the average fintech market share across counties a bank has presence in weighted by its number of branches in each county. Definitions of all independent variables are provided in Table A.2 in the Appendix. Standard errors are clustered at the deal group level (every group of actual and pseudo deals). We report t-statistics in parentheses below each estimate. ***, **, and * indicate significance at the 1, 5, and 10 percent levels.

Matched deals: For each actual investment deal, we create 10 pseudo deals: (1) We match the actual bank investor with 5 pseudo fintech startups that also receive investments in the same year. We select the pseudo fintech firms using propensity score matching based on firm age and the size of the financing round. (2) We match the actual fintech startup with 5 pseudo bank investors in Crunchbase. We then select the pseudo investors using propensity score matching based on bank size, book-to-market ratio, and the two-digit SIC code.

Panel A: Overlap Business (#)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(#)	0.044***	0.039***	0.039***
	(5.41)	(4.78)	(4.70)
Fintech Competition	0.009	0.013	0.015
	(0.55)	(0.79)	(0.86)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3706	3706	3706
Adjusted R^2	0.0982	0.1081	0.0873

Panel B: Overlap Business (%)

Dependent Variable	Actual Investment		
	(1)	(2)	(3)
Overlap Business(%)	0.003***	0.003***	0.003***
	(6.88)	(6.15)	(6.07)
Fintech Competition	0.008	0.012	0.013
	(0.47)	(0.69)	(0.76)
Controls	Yes	Yes	Yes
Fintech Space Dummies	No	Yes	Yes
Deal Group FE	Yes	Yes	Yes
Bank State FE	Yes	Yes	Yes
Fintech State FE	Yes	Yes	Yes
Deal Stage FE	No	No	Yes
Number of observations	3706	3706	3706
Adjusted R^2	0.1037	0.1124	0.0917