The Fundamental Role of Uninsured Depositors in the Regional Banking Crisis*

Briana Chang
University of Wisconsin

Ing-Haw Cheng
University of Toronto

Harrison Hong
Columbia University and NBER

September 22, 2023

Abstract

We re-examine the role of uninsured depositors through the lens of fundamentals and the idea that uninsured depositors are valuable clients who demand loans. We provide new stylized facts showing that banks with more uninsured deposits — who experienced greater equity value declines *during the crisis of 2023* — had greater stock price risk, profitability, market valuations, and executive pay *before the crisis*. To explain these facts, we develop a model where banks better at risk-taking attract large uninsured depositors who have loan demand. Rising interest rates and decreased loan demand reduce lending-relationship values, leading to outflows from riskier banks.

*The authors thank Inmoo Lee and seminar participants at the Korea Advanced Institute of Science & Technology and Korea University for comments. Send correspondence to inghaw.cheng@rotman.utoronto.ca.

The high level of uninsured deposits of Silicon Valley Bank (SVB) has naturally led to a narrative of flighty uninsured depositors worried about bank defaults as a main driver of the regional banking crisis of 2023. However, SVB was also an important bank for Silicon Valley, with lending relationships to large corporate clients with uninsured deposits. Indeed, Sequoia Capital partner Michael Moritz penned an op-ed describing how "For those of us who have worked in Silicon Valley for the past forty years, SVB has been our most important business partner" (Moritz, 2023). S&P Market Intelligence observed that:

> Meanwhile, large corporate depositors that may have balances well above the Federal Deposit Insurance Corp.'s insured limit may use their deposit account to pay payroll, collect money from vendors, and for other regular corporate operations, and may be well-integrated with treasury management services provided by the bank, which would make moving deposit accounts to another financial institution a significant undertaking. (Hayes, 2023)

In this paper, we re-examine the role of uninsured depositors by taking into account the loan demand attached to uninsured deposits. In particular, we propose a fundamentals-based view emphasizing that greater bank risk-taking and uninsured deposits go together in equilibrium. To start, we provide reduced-form evidence from the cross-section of regional banks consistent with this view: banks with more uninsured deposits had bigger equity value declines *during the crisis* but were also riskier, had higher market valuations, and greater executive pay *before the crisis*. To explain these facts, we then develop a model where banks better at taking risks attract large uninsured depositors who demand loans to finance risky projects. We then work out the implications for how changes in interest rates and loan demand lead depositors to reallocate across banks.

Specifically, we establish five stylized facts that, taken together, point to the importance of lending relationships among uninsured deposits. First, banks with greater uninsured deposits experienced worse returns and greater stock price risk than other banks in the period January 2022-March 2023. For example, Figure 1 establishes the importance of uninsured deposits as an important predictor of which regional banks experienced trouble during the peak crisis period. Second, before 2022, banks with greater uninsured deposits were also riskier according to the same price-based measures. Third, and focusing our remaining attention on this prior period, banks with greater uninsured deposits were more profitable, valuable, exposed to commercial loans and non-personal deposits, and experienced greater deposit growth. Fourth, these banks reported capital ratios and accounting measures that did not appear riskier. Fifth, these banks had similar or greater executive pay and incentives, which were themselves related to greater risk.

These facts build a case that banks such as SVB took on uninsured deposits and risky strategies for fundamental reasons. While the emerging narrative after the crisis emphasizes the importance of uninsured deposits in bank runs (Fact 1), this narrative leaves open why uninsured depositors (who are presumably worried about bank defaults) would attach themselves to risky banks as they did even before the crisis (Fact 2). Indeed, during this pre-crisis period, banks with greater uninsured deposits were more profitable and experienced inflows (Fact 3) despite their greater risk, suggesting that they have valuable underlying business strategies. Fact 4 indicates that uninsured deposits capture a dimension of risk beyond those captured by what is on the balance sheet. Fact 5 further supports the idea that risk-taking was part of a business strategy since such strategies require high executive pay and strong incentives at financial firms to execute in equilibrium (Cheng, Hong, and Scheinkman, 2015).

We develop a model of the fundamentals-based view to demonstrate why risk-taking and uninsured deposits go together in equilibrium and what drives the allocation of uninsured deposits across banks. There is a continuum of ex-ante identical uninsured depositors who demand loans for risky projects and have working capital (exceeding the deposit insurance limit) to deposit in a bank. After an uninsured depositor chooses a bank, that bank receives an informative signal about the project's success, e.g., through a better understanding of the project cash flows, and decides whether to invest. There is a continuum of banks with heterogeneous abilities to understand risky projects, modeled through heterogeneous signal precisions, as well as total deposit-taking capacity. Banks post loan and deposit rates ex ante, decide whether to invest in projects, and face a reduced-form convex cost of holding risk. All depositors match with a bank through market clearing.

The model makes two sets of predictions that align with the above facts (with a straightforward extension capturing Fact 5). First, banks that attract greater uninsured depositors in equilibrium also take more risks and are more profitable than other banks. Intuitively, these are more specialized banks who have a better ability to screen projects and thus generate higher returns than less specialized banks. Therefore, they are willing to take on more risky projects despite paying a greater total cost of holding that risk, attracting more uninsured deposits in the process

Second, a decline in the return of risky projects coupled with an increase in the risk-free rate leads to outflows from more specialized banks toward less specialized banks. That is, a risky, high-uninsured deposit bank such as SVB should experience an outflow of uninsured depositors and fall in value after such a shock. This effect occurs because that bank's screening advantage becomes less valuable, which no longer justifies the high cost of risk-taking. This decrease in the match value between an entrepreneur and a risk-taking bank leads to a reallocation of depositors away from that bank. The prediction provides a rationale for outflows from banks like SVB grounded in fundamentals.

We calibrate the model and quantitatively show that fundamentals can affect deposit allocations on the same order of magnitude as what the data describe. An increase in interest rates from approximately zero to 4% generates a reallocation that significantly evens out the distribution of uninsured deposits across banks. In particular, the calibration suggests that a 1-percentage point increase in interest rates translates to a 5-percentage point decrease in uninsured deposits at the bank with the most uninsured deposits. These model-implied effects are if anything larger than what the data describe.

We contribute to the literature by re-examining the role of uninsured depositors in bank risk-taking, why they are important for bank value, and why the deposit flows we saw were rooted in an equilibrium reallocation of depositors across banks. The fundamentals-based view is consistent with the literature emphasizing the importance of the deposit franchise (Drechsler, Savov, and Schnabl, 2017, 2021; Egan, Lewellen, and Sunderam, 2021), relationships (Bharath et al., 2009; Chodorow-Reich, 2013), and specialization (Blickle, Parlatore, and Saunders, 2023; Paravisini, Rappoport, and Schnabl, 2023) for banks. It suggests a role for the value of uninsured depositors in the discussion of future policy and bank regulation (Barr, 2023). We emphasize that it complements and does not exclude the idea that bank runs are important in explaining the events of March 2023 (Benmelech, Yang, and Zator, 2023; Cookson et al., 2023; Diamond and Dybvig, 1983; Drechsler et al., 2023; Egan, Hortaçsu, and Matvos, 2017; Goldstein and Pauzner, 2005; Haddad, Hartman-Glaser, and Muir, 2023; Iyer and Puri, 2012; Jiang et al., 2023b; Koont, Santos, and Zingales, 2023). We intentionally abstract from runs since the literature has clearly established their importance.

1 Motivation and data

1.1 Motivation

We propose a fundamentally-based role for uninsured depositors at regional banks. This view holds that SVB was at the tip of a pattern of banks that required large uninsured deposits to support the banking relationships underlying their specialized risk-taking strategies.

In SVB's case, plenty of background evidence shows how it specialized in serving the technology sector. SVB's largest depositors, each of whom had several hundred million dollars in deposit at the bank, were tech companies such as Roku, Marqeta, and the venture capital firm Sequoia Capital (Chapman and Leopold, 2023). It often had deep ties with these tech companies: Sequoia partner Michael Moritz penned a Financial Times op-ed describing how "SVB provided for tech when everyone else ignored us" (Moritz, 2023). Others have also documented that SVB specialized in making loans and taking deposits fromthe tech industry, including many smaller and medium-sized startups (Gompers, 2023; Chow, 2023). On the loan side, company materials describe the bank "serv[ing] the innovation economy...There are few banks that truly understand venture debt and many that don't" (Argueta, 2023). On the deposit side, companies often used their large deposit accounts for working capital management (Hayes, 2023). Several startups experienced difficulty paying bills after the failure of SVB (Stokes et al., 2023).

SVB was not alone among regional banks in pursuing risky, specialized strategies financed with large, uninsured deposits. Signature Bank embraced cryptocurrencies and, according to its CEO, became a "preeminent player in that space" (DiCamillo, 2021). First Republic Bank specialized in making large loans to wealthy entrepreneurs and bankers that subsequently lost significant value (Eisen, Ackerman, and Driebusch, 2023), and its executives famously declared that "to get best relationship pricing, we want the full deposit relationship...it's a very key focus for us and one of the reasons we've been able to grow deposit balances so quickly" (Delevingne, 2023). Several other banks, such as Bank of Hawaii and Western Alliance, also accumulated significant loan losses (Weil, 2023).

An emerging narrative of the crisis emphasizes the role of flighty uninsured depositors in precipitating bank runs, consistent with the prior literature (Jiang et al., 2023b; Egan, Hortaçsu, and Matvos, 2017). An expanded version of this narrative further emphasizes that SVB, with its high concentration of uninsured deposits, was a mismanaged, outlier bank that spread contagion to other banks who only posed a "passing resemblance" (Ip, 2023; Salmon, 2023). The Federal Reserve Board (Fed), in its report on SVB's collapse, wrote that SVB was a "textbook case of mismanagement" that, "in some respects, was an outlier" due to its "concentrated business model, interest rate risk, and high level of reliance on uninsured deposits" (Barr, 2023). Continuing, the Fed noted that SVB spread contagion even though it was "not extremely large, highly connected to other financial counterparties, or involved in critical financial services."

In contrast, the fundamentals-based view emphasizes that the concentration of uninsured deposits at risk-taking banks such as SVB, First Republic, and others was not accidental, but rather the outcome of valuable equilibrium matches; furthermore, that the fundamental origins of the crisis lay in a decline in match values due to rising interest rates and declining risky opportunities. While contagion and bank runs exacerbate fundamental-driven effects, this view emphasizes the equilibrium relationship between uninsured deposits and risk-taking. In plainer words, SVB was less an outlier, and more a fundamentally risky business whose uninsured depositors were a critical part of its business value.

Motivated by this view, we document five stylized facts that lay the foundation and build the case for the equilibrium model we develop. The first fact focuses on the role of uninsured deposits in explaining bank risk after 2022, while the latter four facts focus on the role in explaining risk and other attributes in the five years prior to 2022. We divide our analysis around the start of 2022 since it was the turning point for when interest rates began to increase sharply and risky investment opportunities such as those in the tech sector began to decline, as Figure 2 depicts.

1.2 Data sources and summary statistics

Our sample consists of publicly traded US banks classified as regional banks under the eight-digit Global Industry Classification Standard (GICS) code #40101015. We select these banks using the historical lists of Compustat GICS codes and match their stock price data from the Center for Research in Security Prices (CRSP) database using the standard CRSP-Compustat link. Our data on Treasury yields and equity factor returns come from the US Treasury and Ken French's website, respectively.[1]

We obtain data on bank deposits from the quarterly bank call reports available through the Federal Financial Institutions Examination Council (FFIEC, Forms 031 and 041). We link the bank to its bank holding company (BHC) using the FFIEC bank relationship map, and then link the BHC to CRSP using the CRSP-FRB link maintained by the Federal Reserve Bank of New York. To cleanly link bank-level depositor composition data with BHC-level stock price data, we require that each BHC contain only one entity for which it has a direct relationship and that it have a 100% equity stake in that entity, which we determine using the FFIEC bank relationship map.[2]

[1]Available online at `https://home.treasury.gov/policy-issues/financing-the-government/interest-rate-statistics` and `https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`, respectively.

[2]We rely on the bank-level call reports instead of the consolidated BHC Form FR Y-9C call reports since only the former contain detailed information about depositor composition. The FFIEC bank relationship map is available online at `https://www.ffiec.gov/npw/FinancialReport/DataDownload`. The CRSP-FRB link is available online at `https://www.newyorkfed.org/research/banking_research/crsp-frb`. The CRSP-FRB link maps some bank-level call reports directly to CRSP firm identifiers, and it is not necessary to map the bank to a BHC in this case.

We obtain our other balance sheet and income statement data from a combination of bank call reports and Compustat. Data about executive pay comes from ExecuComp, and data about boards of directors comes from Institutional Shareholder Services (ISS).

Our sample includes 179 regional banks. We require data on total assets, depositor composition, and market capitalization at the beginning of 2022, an observed return during the March 8–13, 2023 crash, and a 5-year monthly market beta from 2017-2021 estimated with a minimum of 48 months. We further screen out illiquid stocks where our price-based risk measures might be less reliable by requiring that a stock's average price exceed \$5, that its Amihud (2002) illiquidity ratio (average daily absolute return/dollar volume) be less than 10% (per \$1MM dollar volume), and that the stock trade at least 90% of days, over the course of 2021. These screens yield a single cross section of banks for which we can assess pre-2022 and 2022-onward stock price risk cleanly.

Table 1 reports summary statistics. Our key variable of interest is the "uninsured deposit fraction," defined as the fraction of deposit dollars in accounts with balances over the deposit insurance limit of \$250,000 from Schedule RC-O on the call reports. We focus on the gross total dollars in these accounts rather than the amount in excess of the insurance limit, although our main results are similar with either. On average, the uninsured deposit fraction was 55% as of the end of 2021, while the five year average from 2017-2021 was 48%.[3]

Regional banks are small: median total assets, deposits, and market capitalization at the end of 2021 equal \$7, 6, and 1 billion, respectively. We obtain total assets and deposits from the call reports and market capitalization from CRSP as of calendar year-end. We apply our liquidity screens to mitigate biases that may occur due to small stock illiquidity (Ibbotson, Kaplan, and Peterson, 1997). After applying our screens, the median illiquidity ratio and percentage of days without trade are 0.5% and 0.8%. We discuss additional summary statistics in the course of documenting our five facts below.

[3] Prior to 2008-Q4, the deposit limit was \$100,000 for non-retirement deposit accounts and \$250,000 for retirement accounts; prior to 2006-Q2 and going back to 1980, the limit was \$100,000. For a brief history of changes in deposit insurance limits, see the announcements by the Federal Deposit Insurance Corporation at `https://archive.fdic.gov/view/fdic/4000` and `https://archive.fdic.gov/view/fdic/2789`.

2 Five facts about the cross section

2.1 The facts

Fact 1. *Regional banks with greater uninsured deposits were riskier after the start of 2022 compared with other regional banks.*

We focus on stock price risk and calculate returns, return volatilities, market betas, and rate betas between 2022 and 2023:03 using daily returns, applying the Dimson (1979) method to account for possible asynchronous trading. Rate betas equal the estimated coefficient from a regression of stock returns on changes in the average Treasury yield in the term structure and is our measure of interest rate risk. The idea is that a firm's equity is immunized from interest rate risk if its equity value is insensitive to unexpected interest rate movements, although our measure ignores the expected component for simplicity.[4]

Regional banks performed poorly on average in this period. From Table 1, the average (1-standard deviation, or "sd" from now on) return in the 4-day window from March 8-13, 2023 equaled -16% (11.3%), and the broader return over the 2022-onward period equaled -20% (26%). Average (1-sd) realized return volatility, market beta, and rate beta equaled 32% (12%), 0.6 (0.3), and –2.7 (2.5), respectively.

Figure 3 illustrates our first fact by plotting market betas and return volatilities against the uninsured deposit fraction at the start of 2022 (end of 2021). Evidently, banks with greater uninsured deposits had greater realized betas and volatilities.

Table 2 investigates in more detail and reports ordinary least squares (OLS) estimates of the following empirical specification:

$$y_{i,2022/23} = a + b_0\, UNINS_{i,2021} + b_1\, logAssets_{i,2021} + B \times liquidity_{i,2021} + u_i, \tag{1}$$

where $y_{i,2022/23}$ are risk measures estimated from 2022-2023 and $UNINS_{i,2021}$ is the uninsured deposit fraction as of the start of 2022 (end of 2021), our principal variable of interest, and

[4] We estimate rate betas through March 7, 2023 to capture the effect of the general upward trend in rates from 2022-onward on bank stock prices that we discuss in our model.

u_i is the bank-level error term. We include $logAssets_{i,2021}$, the natural logarithm of bank assets, because greater bank size is correlated with greater uninsured deposits (ρ=0.37), perhaps naturally. We include $liquidity_{i,2021}$ to mitigate illiquidity biases in addition to our initial exclusion of extremely illiquid stocks and the use of the Dimson (1979) method in estimating betas. We include quintile indicators of Amihud (2002) illiquidity and, separately, the percentage of days without trade in $liquidity_{i,2021}$.

The estimates show that banks with greater uninsured deposits had greater realized risk. The economic magnitudes are large: a bank with an uninsured deposit fraction that was one-sd (14%) greater than another bank was associated with a 0.43-sd worse return (5% over 4 days) during the peak crisis period and 0.37-sd worse return (9% annualized) over 2022:01-2023:03. That same bank was also associated with a 0.27-sd greater return volatility, 0.21-sd greater market beta, and 0.20-sd more negative rate beta.

Fact 2. *Before 2022, regional banks with greater uninsured deposits were also riskier compared with other regional banks.*

We calculate returns, return volatilities, market betas, and rate betas from 2017 through the end of 2021 using monthly raw returns from CRSP. Regional banks had an average annual return of 9% (1-sd: 7%) from Table 1. Average (1-sd) return volatility, market beta, and rate beta equaled 29% (6%), 1.0 (0.35), and 26.0 (7.5), respectively.

Figure 4 illustrates our second fact that uninsured deposits and risk are correlated in the five-year period leading up to 2022, analogous to the 2022-onward period. The figure plots five-year market betas and volatilities against the five-year average uninsured deposit fraction over 2017-21. As in Figure 3, banks with greater uninsured deposits had greater betas and volatilities.

Table 3 reports OLS estimates of the following specification that relates 5-year average uninsured deposits and risk contemporaneously during the pre-2022 period:

$$y_{i,2017/21} = a + b_0\, UNINS_{i,2017/21} + b_1\, logAssets_{i,2017/21} + B \times liquidity_{i,2017/21} + u_i. \quad (2)$$

We define variables analogously to those in Equation 1, with the exception that all variables represent averages or sensitivities calculated over the five-year period.

The correlation between uninsured deposits and risk is positive and economically large. A bank with a 5-year average uninsured deposit fraction that was 1-sd greater than another bank was associated with a 0.17-sd greater stock return (1% annualized) during the 2017-2021 stock price boom, although the slope estimate is not statistically reliably different from zero. The same bank would have been associated with a 0.22-sd greater return volatility, 0.29-sd greater market beta, and 0.19-sd greater rate beta.

Fact 3. *Before 2022, regional banks with greater uninsured deposits were more profitable, valuable, exposed to commercial loans and non-personal deposits, and experienced greater deposit growth, compared with other regional banks.*

We calculate return on equity (assets) as pretax income scaled by stockholder equity (assets). We abstract from taxes to focus on bank operating profits. Market equity / book equity equals market capitalization divided by total stockholder equity. The market value of assets equals book assets less book equity plus market capitalization, while book assets equals total assets. We calculate these values at the BHC level from Compustat using the last fiscal year value reported each calendar year.

Commercial & industrial (C&I) loans equals the total amount of these loans divided by total assets. Non-personal individual, partnership, and corporate (IPC) deposits equals the amount of IPC deposits not for personal/household/family use divided by total IPC deposits. We interpret this variable as a proxy for deposits held for commercial purposes. We calculate deposit growth as the change in the log deposit base reported from the bank's balance sheet. We winsorize these variables at 1% and 99% levels and calculate five-year 2017-2021 averages with a minimum of three years of data.

Average (1-sd) regional bank pretax return on equity before 2022 equaled 12% (3%), with a return on assets of 1.4% (0.3%), from Table 1. Average (1-sd) equity and asset valuation ratios equaled 1.3 (0.4) and 1.04 (0.04), respectively. The average C&I loan fraction equals

13%, while the average non-personal IPC deposit fraction equals 43%. The average deposit growth was approximately 4% (2%) per annum.

Table 4 reports OLS estimates of the following specification that relates 5-year averages of uninsured deposits to the contemporaneous averages of these variables before 2022:

$$y_{i,2017/21} = a + b_0\, UNINS_{i,2017/21} + b_1\, logAssets_{i,2017/21} + u_i. \tag{3}$$

The estimates suggest that a bank with 1-sd greater uninsured deposits is associated with a 0.27 and 0.21-sd greater return on equity and assets, respectively. The association with equity and asset valuation ratios equals 0.21 and 0.16-sd, while the association with C&I loans and non-personal IPC deposits equals 0.22 and 0.50-sd, respectively. Banks with 1-sd greater uninsured deposits also experienced 0.22-sd greater annual deposit growth.

Fact 4. *There is little evidence that banks with greater uninsured deposits reported riskier capital ratios and accounting measures before 2022.*

We relate the uninsured deposit fraction to regulatory capital ratios and a balance sheet-based measure of the maturity gap between assets and liabilities. We obtain data on regulatory capital ratios directly from Schedule RC-R on the call reports, "Regulatory Capital." Each bank reports its common equity Tier 1 (CET1), Tier 1, and total capital ratios (all divided by risk-weighted assets) alongside the regulatory leverage ratio (which ignores risk weights). From Table 1, average regulatory capital ratios were 13-14%, indicating healthy capitalization levels.

We calculate the bank maturity gap following English, Van den Heuvel, and Zakrajšek (2018) using data from Schedules RC-B (Securities), RC-C (Loans and leases), RC-E (Deposits in Domestic Offices) and RC-F (Deposits in Foreign Offices). The maturity gap equals the weighted-average maturity of assets—securities (including Treasuries, U.S. agency debt, and mortgage-backed securities) and loans—less the weighted-average maturity of deposits, assuming a contractual maturity of zero for demand deposits. The average maturity gap equaled 3.5 years.[5]

We also calculate the dollar value of a basis point (DV01) scaled as a percentage of CET1, which has the interpretation of the percentage of capital depleted when interest rates rise by 1 basis point. We calculate DV01 as the weighted average maturity of assets multiplied by asset values less the same quantity for deposit liabilities. Finally, we also calculate whether or not the bank uses interest rate swaps from Schedule RC-L. The average DV01/CET1 equals 0.29%, and an average of 70% of banks use interest rate swaps.

Regulatory capital ratios showed little correlation with our risk measures. Table 5 reports the OLS estimates of Equation 3 but where the dependent variables are these regulatory capital ratios. Point estimates do suggest that greater uninsured depositors are associated with slightly lower capital ratios—greater risk—although the estimates are not statistically distinguishable from zero. In terms of economic significance, a bank with 1-sd greater uninsured deposit fraction was associated with 0.05-0.10-sd (0.2-0.3%) lower capital ratios and little movement in the regulatory leverage ratio.

Columns 5 and 6 show that, if anything, banks with greater uninsured deposits had a lower maturity gap and DV01 exposure than other banks: a bank with 1-sd greater uninsured deposits was associated with a 0.20 and 0.22-sd lower measure of interest rate risk. There is some suggestive evidence in column 7 that banks with greater uninsured deposits are less likely to hedge using interest rate swaps, although the effect is not statistically reliably different from zero. Economically, a bank with 1-sd greater uninsured deposits was 5% less likely to hedge using interest rate swaps.

[5] As English, Van den Heuvel, and Zakrajšek (2018) discuss, the measure has several caveats as a balance sheet measure of interest rate risk: it does not account for embedded options in instruments such as residential mortgages, does not account for the relative dollar value of assets versus liabilities, does not cover all assets and liabilities, focuses on maturity rather than duration, and does not include hedges. Following their method,, we use the midpoint of each maturity for each bin reported in the call reports with a maturity of 20 (5) years when the bin indicates securities with maturity or next repricing over 15 (3) years away. For example, for RMBS securities with maturity or next repricing date of over 5 years through 15 years, we assume a maturity of 10 years. When calculating the weights for each bin, we use total assets or total liabilities in the denominator even though not all assets on the balance sheet have maturity break-outs. On average, assets with maturity breakdowns cover 87% of total assets for banks in our sample, and liabilities with maturity breakdowns (counting demand deposits as zero maturity) cover 92% of total liabilities. Our regression inferences are unchanged if we use the total of only assets and liabilities with maturity breakdowns in the denominator when calculating weights.

Fact 5. *Banks with greater uninsured deposits had similar or greater pay and incentives, without strong evidence of weaker boards, and pay was related to risk, before 2022.*

We next investigate whether uninsured deposits are linked to pay and incentives, and whether these latter variables help explain risk-taking. Total top-5 executive compensation equals the average total direct compensation (TDC1 in Execucomp) to the top-5 most highly paid executives listed in the company's proxy statement plus the CEO (if not already included). Executive ownership includes the sum of all share ownership by executives including delta-weighted options divided by shares outstanding, where we calculate option deltas in a manner similar to Coles, Daniel, and Naveen (2013) from the Execucomp outstanding awards tables. We calculate the percentage of board members that ISS classifies as independent well as the average share ownership of independent directors.

Table 6 panel A reports estimates of Equation 3 but where the dependent variables are average pay and ownership of top-5 executives, the fraction of the board that is independent, and the average ownership of independent directors. Including $logAssets_{i,2017/21}$ in Equation 3 is particularly important in these regressions given the well-known relationships between pay, incentives, and size (Baker and Hall, 2004). Our sample relating uninsured deposits, pay, and risk-taking contains only 73 banks because several banks do not fall within the S&P 1500 coverage of Execucomp. We therefore concentrate on point estimates and remain cautious about statistical significance.

The estimates suggest that banks with greater uninsured deposits had similar or greater pay and incentives. A bank with 1-sd greater uninsured deposits is associated with 0.08-sd greater pay and 0.33-sd greater insider ownership, the latter statistically significant at the 5% level. Boards of banks with greater uninsured deposits are slightly less independent, but its independent directors have slightly greater share ownership.

Table 6 panel B reports estimates from a specification that relates risk to pay:

$$y_{i,2017/21} = a + b_0\, Top5Pay_{i,2017/21} + b_1\, logAssets_{i,2017/21} + u_i. \tag{4}$$

The estimates show that, even in the limited sub-sample, executive pay is correlated with risk. A bank with 1-sd greater pay (residual from size) was associated with 0.44-sd greater return volatility, 0.32-sd greater beta, and 0.43-sd greater rate beta. Panel C reports that insider ownership also tends to be positively correlated with risk.

2.2 Summary and discussion

The facts suggest that SVB was part of a pattern where banks take risks financed by uninsured deposits as part of their business strategy. Fact 1 emphasizes the importance of uninsured depositors in explaining which banks ran into trouble from 2022 onward. This evidence is consistent with Egan, Hortaçsu, and Matvos (2017), Haddad, Hartman-Glaser, and Muir (2023), Iyer and Puri (2012), Iyer, Puri, and Ryan (2016), Jiang et al. (2023b), and Martin, Puri, and Ufier (2023) who emphasize the role of uninsured deposits in bank runs such as the one we saw starting March 8, 2023. The evidence will also be consistent with our model where declining risky opportunities coupled with rising interest rates drive deposit outflows and bank troubles at banks with significant uninsured deposits.

Fact 2 shows that there was also a strong relationship between uninsured deposits and risk in the five years before 2022. Banks with greater uninsured deposits were associated with significantly greater equity risk. The positive average rate beta suggests that increases in interest rates were typically associated with bank stock price increases. This finding is consistent with a correlation between rate increases and good economic news and banks earning high spreads over deposit rates (Drechsler, Savov, and Schnabl, 2017, 2021; Hutchison and Pennacchi, 1996). Interestingly, stock prices of banks with greater uninsured deposits were more positively sensitive to interest rates before 2022 but were more negatively sensitive to interest rates from 2022 onward. Our model below can explain this shift.

Fact 3 shows that banks with greater uninsured deposits also tended to be more profitable, valuable, were more exposed to commercial activity, and attracted more deposits, despite their greater risk, compared with other banks during this prior period. This evidence suggests that greater uninsured deposits were linked to valuable underlying business strategies. It also supports the anecdotes of banks like SVB and First Republic pursuing risky strategies to generate more profits and attract uninsured deposits. Greater bank profits during good times, particularly greater ROE, also indicate greater underlying bank risk (Meiselman, Nagel, and Purnanandam, 2020).

Fact 4 suggests that greater uninsured deposits capture a dimension of risk not captured by balance sheet capital ratios and maturity mismatches. It is consistent with the literature that suggests these measures may be only weakly informative of bank risk potentially due to manipulation (Begley, Purnanandam, and Zheng, 2017). Our results on interest rate swaps are consistent with Jiang et al. (2023a), who find mixed evidence on interest rate swap usage among banks with greater uninsured deposits. More broadly, Fact 4 opens the door to other risk channels beyond those captured by these balance sheet measures.

Fact 5 further supports the idea that risk-taking was part of a business strategy since risk-taking strategies at financial firms require high executive pay and strong incentives to execute in equilibrium (Cheng, Hong, and Scheinkman, 2015). Others, including the Fed, have suggested that uninsured deposits and bank failures were due to mismanagement or governance failures (Barr, 2023; Warmbrodt, 2023). While not ruling out aspects of mismanagement—SVB notoriously did not have a chief risk officer for several months leading up to the crisis (Johnson, Rosenblatt, and Dolmetsch, 2023)—the evidence rules in the possibility that banks with uninsured deposits compensated their executives for taking risks.

3 A fundamentals-based model of uninsured deposits

3.1 Motivation and preview of key results

Why do greater uninsured deposits and greater bank risk-taking go together? Our insight is that banks who specialize in financing risky projects compete to attract large deposit accounts in the interests of establishing a relationship with, and obtaining better information about, each client. Relationships with uninsured depositors allow the bank to better screen and fund risky projects. Through this channel, the relationship between a bank and an uninsured depositor affects both the asset and liability side of bank.

Our model intentionally does not feature runs or contagion, forces that other papers have studied extensively. Instead, we highlight the fundamental forces that describe the equilibrium allocation of depositors across banks and how reallocation occurs. Contagions and runs likely exacerbate many of these forces, but lie outside of our model.

3.2 Setup

There are three types of agents: a unit measure of uninsured depositors, a unit measure of banks, and a large measure of insured depositors. We model uninsured depositors as agents who are potential entrepreneurs and have large deposit amounts d_u, where d_u exceeds the deposit insurance limit and can be interpreted as the working capital needed for a potential project. We assume that the investment opportunity arrives at the i.i.d. rate of λ per dollar, so that each uninsured investor has an investment opportunity with probability λd_u. Each project requires an investment of I along with an exogenous amount of d_u working capital, where $d_u < I$.

Banks differ in two dimensions (D, b): their total dollar deposit-taking capacity D and their ability to screen the risky asset b, which we describe in detail below. We think of b as representing the bank's specialization in understanding risky projects. For simplicity, we assume that banks are funded only by deposits. Thus, D also represents a bank's total assets. Let $g(D, b)$ represent the density function of different banks. The purpose of D is to provide independent variation of bank size from depositor composition in the model.

Insured depositors have small deposits d_0 below the deposit insurance limit and do not have investment opportunities.[6] They receive an exogenous deposit rate $\rho_o = \nu_l r_f$ where $\nu_l \leq 1$ and r_f is the risk-free rate and are not strategic. The parameter ν_l represents a discount that the insured depositors are willing to take, which we take as given. In the special case where $\lambda = 0$, uninsured and insured depositors only differ in their deposit size.

[6]This is consistent with our assumption that agents need to have significant working capital to implement a project.

In this case, uninsured depositors do not generate additional value, as banks can substitute them with more insured depositors instead.

There are three periods, $t \in \{0, 1, 2\}$. At time $t = 0$, banks post rates and uninsured depositors choose a bank. At time $t = 1$, uninsured depositors find out if they have a project, and the bank receives their signal b about the project and chooses whether to invest. At time $t = 2$, the project cash flows and payments are realized.

Information structure and loan decisions in period 1. In period 1, each entrepreneur has an investment project with i.i.d. probability λd_u. The project has a binary payoff that realizes at period 2 and depends on a latent state variable s (unknown to all agents). The variable s is distributed according to a cumulative density function F and is i.i.d. across projects. Conditional on s, the project's payoff equals $(1+\sigma)I$ if $s \geq z$ and $(1-\sigma)I$ if $s < z$ for some exogenous threshold z. Thus, ex ante, the project succeeds with unconditional probability $1 - F(z)$ and fails with probability $F(z)$.

We assume that, if the project succeeds, the return is greater than the bank's exogenous outside option r_B. However, the project is negative NPV for the bank relative to their outside option r_B unless the bank obtains more information about the project.[7] That is,

$$(1 - F(z))\,(1 + \sigma) + F(z)(1 - \sigma) = 1 + (1 - 2F(z))\,\sigma < (1 + r_B). \tag{5}$$

We think of $r_B = \nu_h r_f$ as representing the return on standard loans or investments that a bank can potentially earn, where $\nu_h \geq 1$ represents the banks' ability to earn additional returns relative to the risk-free rate r_f.

To capture the idea that the bank can learn more about the entrepreneurs if the bank has access to their accounts, we assume the bank receives an additional signal about the project at period 1 if and only if the entrepreneur has a deposit account with the bank. For simplicity, we assume the bank receives the signal only if the depositor deposits the full

[7] Because each project is negative NPV ex ante, an entrepreneur would never choose to deposit their working capital and apply for a project loan at two different banks.

working capital amount d_u.[8]

For every entrepreneur that has a relationship with bank (b, D), the bank receives a noisy signal x about project success, and banks with greater $b \in [0, 1]$ receive more informative signals. The structure of the signal is that $x = 0$ if and only if the project will fail, and $x = 1$ indicates project success but with false positives. Specifically, $x(s, b) = \mathbb{1}\{s \geq bz\}$, so that there there are false positives of $x = 1$ if $bz \leq s < z$. Thus, the parameter b captures the informativeness of the signal: a greater b means a more informative signal and lower probability of a false positive. By construction, whenever $x = 0$, the bank knows that the project is bad and will not invest.

We assume that all banks receive signals that are sufficiently informative so that, for any bank, it is optimal to invest in the project conditional on getting positive news:

Assumption 1 (The project is positive NPV when $x = 1$.)**.** *All $b \in [b^L, b^H]$ satisfy $b > \bar{b}$, where $\bar{b}$ solves:*

$$\frac{1 - F(z)}{1 - F(\bar{b}z)}(1 + \sigma) + \left(1 - \frac{1 - F(z)}{1 - F(\bar{b}z)}\right)(1 - \sigma) = 1 + r_B.$$

Putting it all together, bank (b, D) receives signal $x = 1$ with probability $1 - F(bz)$ for any given project, which is also the probability of investment for bank b. A project's excess return conditional on investment for bank b, denoted by $\alpha(b)$, equals:

$$\begin{aligned}
\alpha(b) &\equiv \left(\frac{1 - F(z)}{1 - F(bz)}(1 + \sigma) + \left(1 - \frac{1 - F(z)}{1 - F(bz)}\right)(1 - \sigma)\right) - (1 + r_B) \\
&= (1 - \sigma) + \frac{1 - F(z)}{1 - F(bz)}2\sigma - (1 + r_B) = \frac{1 - F(z)}{1 - F(bz)}2\sigma - (\sigma + r_B),
\end{aligned}$$

which increases with b as more informed banks are less likely to make mistakes. Given a project, a more informed bank with greater b invests with a lower unconditional probability

[8] This assumption can be relaxed by assuming that the informativeness of a bank's signal is proportional to the amount of the working capital deposited. That is, suppose that an entrepreneur deposits $\frac{d_u}{n}$ across n banks. Then the precision of bank b's signal is $\frac{b}{n}$, and an entrepreneur can potentially receive a loan size of $\frac{1}{n}$ from each bank. One can show that it is always optimal to have one very precise bank instead of n moderately informed banks.

and has a greater excess return conditional on investment.

Relationships in period 0. We now turn to the decision of forming relationships between banks and uninsured depositors. A bank offers loan rate R and deposit rate ρ_u. An entrepreneur chooses a bank to deposit their working capital accordingly, understanding that this relationship would improve her chance of getting a loan if an investment opportunity arrives. Recall that, by construction, the project has negative NPV and thus will not be financed unless the entrepreneur establishes a deposit relationship. Moreover, since a bank only receives a signal if they have access to all the working capital of an entrepreneur, an entrepreneur will choose only one bank.

Expected payoffs of uninsured depositors. Given any (R, ρ_u) offered by a bank (b, D), the expected payoff of an entrepreneur equals:

$$W(R, \rho_u, b) = \lambda d_u I(1 - F(bz)) \left(\frac{1 - F(z)}{1 - F(bz)} (\sigma - R) \right) + (1 + \rho_u)\, d_u, \tag{6}$$

where the first term represents her expected value of the project, which she receives loan for with probability $\lambda d_u(1 - F(bz))$, is successful with probability $\frac{1-F(z)}{1-F(bz)}$ conditional on investment, and receives net payoff $(\sigma - R)$ conditional on success. The second term represents the interest earned on her deposited working capital.

Expected payoffs of banks. We assume that a bank's cost of taking risk (e.g., through its cost of capital and internal risk management capability) is proportional to the bank's deposit-taking capacity D and is an increasing and convex function of the fraction of dollars the bank invests in risky projects. Specifically, let $\mu(b, D)$ represent the number of uninsured depositors matched to the bank (which will be determined in equilibrium) so that the total dollar amount the bank invests in risky projects is $\lambda d_u I \mu\,(1 - F(bz))$. Denote the fraction of dollars invested in risky projects for a bank with capacity D by:

$$\chi(b, D, \mu) \equiv \frac{\lambda d_u I \mu\,(1 - F(bz))}{D}.$$

We assume that the cost is given by $C(\chi, D) = Dr_f\xi(\chi)$, where $\xi(0) = 0, \xi'(0) = 0, \xi'(\chi) > 0$ $\forall\chi > 0$, and $\xi''(\chi) > 0$. That is, $C(\chi, D)$ is proportional to the capacity D, conditional on χ. We interpret this risk-taking cost as related to the cost of capital in the market, so that it also proportional to the risk-free rate. The cost is zero if the bank takes on zero risky projects (i.e., $\xi(0) = 0$).

Thus, the expected payoff of bank (b, D) conditional on having μ entrepreneurs equals:

$$
\begin{aligned}
V(b, D, \mu|R, \rho_u) = & \left(D - \lambda d_u I\mu(1 - F(bz))\right)(1 + r_B) \\
& + \lambda d_u I\mu(1 - F(bz))\left\{\left(\frac{1 - F(z)}{1 - F(bz)}(1 + R) + \left(1 - \frac{1 - F(z)}{1 - F(bz)}\right)(1 - \sigma)\right)\right\} - Dr_f\xi(\chi(b, D, \mu)) \\
& - (1 + \rho_u)d_u\mu - (1 + \rho_o)(D - d_u\mu).
\end{aligned} \tag{7}
$$

The first line represents the return on deposit money the bank invests in its outside option. The second line represents the expected return of the banks' loans on the risky projects net of the cost of holding risk. Specifically, the bank puts $\lambda d_u I\mu(1 - F(bz))$ dollars into risky projects, and it will receive $1 + R$ per dollar for each project that succeeds and $1 - \sigma$ per dollar for each project that fails, and pay cost $C(\chi, D)$. The final line represents payments to μd_u uninsured depositors (each paid deposit rate ρ_u) and $D - \mu d_u$ insured depositors (each paid exogenous deposit rate ρ_o). If the bank does not attract any uninsured depositors and $\mu = 0$, then banks simply earn the net spread of the outside option return over the insured deposit rate, $V(D, b, 0) = D(\nu_h - \nu_l)r_f$.

Equilibrium. We solve for a competitive equilibrium. The endogenous equilibrium quantities are an allocation function $\mu^*(b, D)$ that determines the quantity of uninsured deposits at each bank as well as a loan rates $R(b, D)$ and deposit rates $\rho_u(b, D)$ offered by each bank. Entrepreneurs choose banks optimally, and banks choose investments, loan rates, and deposit rates optimally. Market-clearing for deposits demands $\int \mu^*(b, D)\, g(b, D)\, db\, dD = 1$. For simplicity, we focus on the parameter space that will generate interior solutions with $\mu(b, D)d_u/D < 1$ so that no bank has only uninsured deposits.

3.3 Characterization

We sketch the intuitions that characterize the unique equilibrium and provide the formal solution in the Appendix. Since entrepreneurs are identical ex ante, they must earn the same expected payoff in equilibrium W^*. In equilibrium, banks compete and adjust loan/deposit rates until the marginal benefit of attracting one more entrepreneur equals the marginal cost. Equivalently, banks effectively choose how many uninsured depositors to attract given W^*.

Let $s(b, D) \equiv \frac{\mu(b,D)d_u}{D}$ denote the fraction of uninsured dollars for a bank. From Equation 7, we can write banks' profits relative to assets as a function of the fraction of uninsured deposit dollars. This yields:

$$\frac{V(b,D)}{D} = \max_s \left(v_h - v_l\right) r_f + \hat{\chi}(b,s)\alpha(b) - r_f \xi(\hat{\chi}(b,s)) - s\left(\frac{W^* - (1+\rho_0)d_u}{d_u}\right), \tag{8}$$

where $\hat{\chi}(b,s) \equiv \lambda I(1 - F(bz))s$ re-writes the risky loan fraction $\chi(b, D, \mu)$ as a function of bank b's uninsured dollar fraction s. The first term represents the spread earned from standard loans. The second term represents the excess return earned from the project loans brought by uninsured depositors. The third term is the cost of handling project loans. The last term represents the payoff required by the uninsured depositors relative to the insured depositors.

One can see that the optimal fraction of uninsured dollars s for the bank is independent of capacity D, as the right hand side of Equation 8 is a function of b but not D. That is, if two banks have the same b, the uninsured depositor fraction and thus the risky loan fraction $(\hat{\chi})$ must be the same. This also implies that the bank with a larger capacity will attract more uninsured deposits: $\mu^*(b, D) = D\mu^*(b, 1)$ so that $s(b, D') = s(b, D)\forall(D, b)$. Thus, we now proceed by directly characterizing $s^*(b) \equiv \frac{\mu(b,D)d_u}{D}$.

Allocation of uninsured depositors. In equilibrium, $s^*(b)$ must satisfy the following first order condition for all b:

$$\lambda I(1-F(bz))\left(\alpha(b)-r_f\xi'(\hat{\chi}(b,s))\right)-\left\{\frac{W^*-(1+\rho_0)d_u}{d_u}\right\}=0. \tag{9}$$

The first term represents the marginal change in the bank's utility from adding an uninsured depositor through an additional potential investment opportunity, which equals the excess return of a risky project $\alpha(b)$ net of the marginal cost of risk times the probability of investing $\lambda(1-F(bz))$. The second term represents the effective price that the bank must pay per uninsured depositor relative to insured depositors.

Proposition 1 (Equilibrium)**.** *The equilibrium $\{W^*, s^*(b)\}$ exists, is unique, and is efficient, where $s^*(b)$ must satisfy the following ODE:*

$$\frac{ds^*(b)}{db}=\frac{-F'(bz)z}{(1-F(bz))^2}\left\{\left(\frac{\sigma+r_B}{r_f}\right)\frac{1}{\xi''(\hat{\chi}(b,s^*(b))}+\frac{1}{\lambda I}\left(\frac{\xi'(\hat{\chi}(b,s^*(b))}{\xi''(\hat{\chi}(b,s^*(b))}+\hat{\chi}(b,s^*(b))\right)\right\}, \tag{10}$$

and the market clearing condition $\int s^*(b)D\,g(b,D)\,db\,dD=d_u$. The equilibrium playoff of uninsured depositors W^* is given by Equation 9.

Equation 10 follows from differentiating Equation 9 with respect to b. Note that Equation 9 implies that the equilibrium is also efficient, as each bank takes on enough uninsured depositors so that the marginal value of each depositor equals its marginal cost.

Loan and deposit rates. Given the allocation $s^*(b)$, Equation 10 pins down the payoff of uninsured depositors. Two observations are in order.

First, observe from Equation 6, the expected payoff of uninsured depositors W^* is independent of b conditional on the loan and deposit rate (R,ρ_u). This is because entrepreneurs gain only when the project succeeds, which happens with probability $1-F(z)$ that is independent of b, and banks bear the cost of failed projects. Hence, we look for (R,ρ_u) that is also independent of b.

Second, the equilibrium pins down the payoff of uninsured depositors up to W, where:

$$\frac{W^* - (1+\rho_o)d_u}{d_u} = \lambda I \left(1 - F(z)\right)(\sigma - R) + (\rho_u - \rho_0) .$$

That is, there are generally different ways to compensate uninsured depositors with different combinations of loan rates R and deposit rates ρ_u. As such, we further impose that (R, ρ_u) is characterized by $\eta \in (0,1)$ such that:

$$\lambda I \left(1 - F(z)\right)(\sigma - R) = \eta \left(\frac{W^* - (1+\rho_o)d_u}{d_u}\right), \tag{11}$$

and:

$$(\rho_u - \rho_0)\, d_u = (1-\eta) \left(\frac{W^* - (1+\rho_o)d_u}{d_u}\right). \tag{12}$$

A higher η means that uninsured depositors are compensated by lower loan rates instead of greater deposit rates. From Equation 11, $\eta > 0$ guarantees that uninsured depositors are rewarded if the project succeeds. From Equation 12, $\eta < 1$ guarantees that it is optimal for uninsured depositors not to divide their deposits into different banks even if they do not have an investment project at period 1.

3.4 Predictions

Uninsured deposits, bank risk, and profits. Equation 10 directly implies that higher-b banks have more uninsured depositors relative to their deposit size and take on more risks. With a slight abuse of notation, let $V(b) \equiv \frac{V(b,D,\mu^*(b,D))}{D}$ represent bank profits scaled by assets.

Proposition 2 (Correlation of uninsured deposits, bank risk, and profits)**.** *In equilibrium, a bank with higher screening ability b has a higher uninsured deposit fraction s, risky loan fraction χ, and profits V, than a bank with lower screening ability.*

Note that higher-b banks have greater profits than lower-b banks because they are better at screening projects and creating value from each depositor, despite taking more risk.

Indeed, in equilibrium, $s^*(b)$ increases quickly enough with b so that the risky loan fraction $\chi(b, s^*(b)) = \lambda I(1 - F(bz))s^*(b)$ increases with b despite higher-b banks being more selective about projects.

Changes in interest rates and project returns. We now study comparatives statics to establish which banks experience outflows of uninsured depositors when interest rates and the return on the risky project σ changes. We also study profits $V(b)$ and scaled profits $V(b)/r_f$. We scale profits $V(b)$ by the risk-free rate to account for the basic level effect within the model where an increase in interest rates associated with better investment opportunities increases all banks' profits. Specifically, if the project return moves proportionally with the risk-free rate (i.e., $\frac{\sigma}{r_f}$ remains the same), then the allocation of uninsured depositors remains unchanged, $V(b)$ increases for all b, and $V(b)/r_f$ remains unchanged. We define the change in scaled profits as $\Delta(b) \equiv \frac{\tilde{V}(b)}{\tilde{r}_f} - \frac{V(b)}{r_f}$, where $\frac{\tilde{V}(b)}{\tilde{r}_f}$ represents bank b's valuation under a new set of parameters.

Proposition 3 (Effect of interest rates and project returns on deposits and profits.). *For a decrease in $\frac{\sigma}{r_f}$, there exists $\hat{b} \in (b_L, b_H)$ such that there is a deposit outflow (inflow) for $b > \hat{b}$ ($b < \hat{b}$). Moreover, $\Delta(b) < 0$ if and only if $b > \hat{b}$, and banks with greater $b' > b > \hat{b}$ experience greater scaled valuation declines: $\Delta(b') < \Delta(b) < 0$.*

Since the equilibrium is efficient, one can understand the result from the viewpoint of a planner: a lower $\frac{\sigma}{r_f}$ lowers the value of risky projects, which in turn lowers the value of bank expertise. Since the cost of holding risk is convex in the risky loan fraction χ, it is optimal to make uninsured depositors more evenly distributed across banks. As a result, more (less) specialized banks experience outflows (inflows) of uninsured depositors.

Relationship to empirical facts. Propositions 2 and 3 provide a fundamentals-based rationale for the facts we document in Section 2. The environment in the five years prior to 2022 were arguably associated with period of large or increasing σ/r_f as the economy boomed, and even the pandemic offered new, risky opportunities for many companies. The propositions suggest that banks with greater uninsured deposits such as SVB should be riskier, more profitable, more valuable, and should receive inflows compared with other banks during this period, consistent with the empirical facts. Moreover, banks like SVB had higher-than-average (positive) rate betas prior to 2022, suggesting that interest rate increases were good news on average for SVB and that σ/r_f was decreasing during this period.

On the other hand, the 2022-onward period of interest rate increases coupled with a decline in risky opportunities (especially in the technology sector) is arguably characterized by lower or declining σ/r_f. The propositions suggest that this decline in σ/r_f triggered the greatest outflow of uninsured depositors and portended trouble at banks such as SVB, consistent with the facts and observation. Indeed, high-uninsured deposit banks like SVB had lower-than-average rate betas (often negative) from 2022 onward, suggesting that interest rate increases were bad news and that σ/r_f was declining from 2022 onward.

4 Quantitative Analysis

In this section, we first calibrate our model and then conduct a quantitative analysis to see how much outflow of uninsured depositors can be explained by our mechanism.

4.1 Calibration

Since Proposition 2 shows that $s^*(b)$ increases with b, we can rank banks based on the fraction of their uninsured dollars s. Let $i \in [0,1]$ represent such a rank, with $i = 1$ representing the bank with the greatest uninsured dollar fraction and $i = 0$ representing the bank with the lowest. Let $b[i]$ and $s[i] \equiv s^*(b[i])$ represent the associated screening ability and fraction of uninsured dollars of a bank at rank i. Before proceeding further, we describe the distributional and functional form assumptions we make to map the model to the data.

We first make a distributional assumption that will help pin down $b[i]$. Define $\kappa[i] \equiv 1 - F(b[i]z)$ as the probability of investing in a project for bank $b[i]$. Observe from Equation 7 that $\kappa[i]$ is the key payoff-relevant quantity and that $\kappa[i]$ is decreasing in i, since a bank with a higher ranking is more selective. We assume that $\kappa[i]$ follows a uniform distribution between $[\kappa_H - \Delta, \kappa_H]$, where κ_H and Δ are numbers we will calibrate. That is,

$$\kappa[i] = \kappa_H - i\Delta.$$

We will also calibrate $Z \equiv 1 - F(z)$, the unconditional probability the project succeeds project loan success rate. Note that $\kappa[i] - Z \geq 0 \ \forall i$, and this quantity represents the unconditional probability that bank i makes a mistake.

We assume that the cost of holding risk follows the functional form:

$$\xi(\chi) = \frac{\delta}{1+\phi}\chi^{1+\phi},$$

where the parameters δ and ϕ represent scale and convexity parameters, respectively. For simplicity, we fix $\phi = \frac{1}{2}$ and look to calibrate δ. Next, we collect λ and I together into a single quantity to calibrate, $\lambda^e \equiv \lambda I$, which one can interpret as the effective investment opportunity.

Given these assumptions, we need to calibrate 8 parameters: $\{\kappa_H, \Delta, Z, \delta, \lambda^e, \sigma, r_B, v_l\}$. To do so, we target the 8 moments summarized in panel A of Table 7. The key data variables that drive our calibration are uninsured deposits, C&I loans, and pretax ROA, which map to s, χ, and v, respectively.[9] We will also use observed deposit rates, which we calculate as quarterly deposit interest expense over prior-quarter deposit dollars. We fix $\bar{S} = 0.48$, the observed mean of s in the data. We assume an interest rate of $r_f = 0.1\%$ in anticipation of our counterfactual exercises. Lastly, we assume $\eta = \frac{1}{2}$ since we do not observe C&I-specific loan rates. This results in the compensation to uninsured depositors being equally distributed between deposit rates and loan rates equally.

The moments both include means and standard deviations of model quantities. The key object is the allocation of uninsured depositors, we thus target the dispersion of the share

[9] Since banks in the model have D assets for simplicity, for our calibration we calculate C&I loans as a fraction of deposits rather than assets in the data.

of uninsured dollars given the mean $\bar{S}$. We target both the mean and standard deviations of C& loans, $\chi[i]$. Moreover, since the model predicts that the ratio of these can be mapped to the underlying characteristic of bank i through the relationship:

$$\frac{\chi[i]}{s[i]} = \lambda^e \kappa[i],$$

we further use the mean and standard deviation of $\chi[i]/s[i]$ to pin down information about λ^e, κ_H, and Δ. Lastly, we target the mean and standard deviation of ROA (v) and the mean deposit rate. Within the model, the deposit rate for bank i averaged across insured and uninsured deposits equals:

$$\rho[i] \equiv s[i]\rho_u + (1 - s[i])\,\rho_0 = \rho_0 + s[i](\rho_u - \rho_0).$$

We calibrate the model by minimizing the (equally-weighted) sum of squared errors in the data and model moments. A set of parameters must generate an allocation allocation of $s[i]$ that satisfies Equation 10, where the initial condition is such that $\int s[i]di = \bar{S}$, where $\bar{S}$ is the mean of $s[i]$ in the data.

Panel B of Table 7 reports calibrated model parameters. Overall, the calibrated model matches means and the dispersion of share of uninsured depositors well. The model misses the dispersion in ROA (v) and χ by wide margins. One explanation could be that other heterogeneity in the data drives ROA and C&I loans that the model does not capture.

4.2 Quantitative model-implied deposit flows

We now quantify the deposit flows implied by Proposition 3 from an increase in interest rates using our calibrated parameters. The Proposition predicts that banks with higher (lower) screening ability will outflows (inflow) of uninsured depositors. Figure 5 illustrates the allocation of uninsured depositors $\frac{s[i]}{\bar{S}}$ in a low-rate regime (where $r_f = 0.1\%$, the level of short-term rates at the start of 2022) and under a high-rate regime with $r_f = 4\%$ (the region where interest rates ended up, per Figure 2).

The figure shows that interest rate movements provide a strong fundamental force that reallocate uninsured deposits across banks. The low-rate regime (blue, solid line) features significant heterogeneity in the equilibrium allocation of uninsured deposits: the ratio of uninsured deposits of the bank with the most uninsured deposits over the average bank is 1.5. As rates increase, however, the allocation evens out across banks. In the high-rate regime (red, dashed line), the same ratio for the highest-uninsured deposit bank is 1.1. Given the 4-percentage point increase in interest rates and that these ratios are scaled around an average of $\bar{S} = 0.48$, the estimates imply that, at the highest-uninsured deposit bank, a 1-percentage point increase in interest rates translates to a 5-percentage point decrease in uninsured deposits due to fundamental forces.

The figure also shows that fundamentals can affect deposit allocations on the same order of magnitude as what the data describe. To compare model-implied estimates to the data, the figure also plots actual values of $\frac{s[i]}{\bar{S}}$ for three time periods: 2017-2021 (blue, low-rate regime), 2022 (yellow, high-rate regime excluding 2023), and 2022-2023Q1 (high-rate regime including 2023 but excluding failed banks such as SIVB). Consistent with our model predictions, the allocation of uninsured depositors in the data becomes more evenly distributed after 2022. The model-implied effects are if anything larger than in the data.

We focus our study on the endogenous re-allocation of deposits within the regional banking sector. In reality, endogenous deposits flows from regional banks towards larger banks, or out of the aggregate banking sector, are likely important forces. Drechsler, Savov, and Schnabl (2017) estimate that a 1-percentage point increase in the federal funds rates translates to a 3-percentage point contraction in aggregate deposits. We leave the question of how insured and uninsured deposits endogenously flow across, into, and out of the aggregate banking sector for future research.

5 Conclusion

We provide reduced-form evidence and a model supporting a fundamentals-based role for uninsured depositors in the regional banking crisis by pointing out that uninsured deposits and bank risk-taking go together in an efficient equilibrium. Banks more specialized in understanding risky projects take on greater uninsured deposits and risky projects despite the greater cost of holding that risk because they create more value from uninsured deposits than other banks. As interest rates increase and risky opportunities decline, these banks experience outflows and declines in profits as deposits reallocate across banks. Accounting for a fundamentals-based role for uninsured depositors suggests important trade-offs when discussing future policy and bank regulation surrounding depositor composition.

References

Amihud, Y. 2002. Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets* 5:31–56. ISSN 1386-4181. doi:https://doi.org/10.1016/S1386-4181(01)00024-6.

Argueta, A. A. 2023. Understanding venture debt financing. *Startup Insights from Silicon Valley Bank* Online: https://www.svb.com/startup-insights/venture-debt/how-does-venture-debt-work.

Baker, G. P., and B. J. Hall. 2004. Ceo incentives and firm size. *Journal of Labor Economics* 22:767–98. doi:10.1086/423154.

Barr, M. S. 2023. Review of the Federal Reserve's supervision and regulation of Silicon Valley Bank. Board of Governors of the Federal Reserve System.

Begley, T. A., A. Purnanandam, and K. Zheng. 2017. The strategic underreporting of bank risk. *The Review of Financial Studies* 30:3376–415. ISSN 0893-9454. doi:10.1093/rfs/hhx036.

Benmelech, E., J. Yang, and M. Zator. 2023. Bank branch density and bank runs. doi:http://dx.doi.org/10.3386/w31462. NBER Working paper.

Bharath, S. T., S. Dahiya, A. Saunders, and A. Srinivasan. 2009. Lending Relationships and Loan Contract Terms. *The Review of Financial Studies* 24:1141–203. ISSN 0893-9454. doi:10.1093/rfs/hhp064.

Blickle, K., C. Parlatore, and A. Saunders. 2023. Specialization in banking. doi:http://dx.doi.org/10.2139/ssrn.4420527. SSRN Working paper.

Chapman, L., and J. Leopold. 2023. The big names that got backstop for billions in uninsured SVB deposits. *Bloomberg* Online: https://www.bloomberg.com/news/articles/2023-06-23/fdic-insured-billions-in-deposits-for-sequoia-other-top-svb-customers.

Cheng, I.-H., H. Hong, and J. Scheinkman. 2015. Yesterday's heroes: Compensation and risk at financial firms. *The Journal of Finance* 70:839–79. doi:https://doi.org/10.1111/jofi.12225.

Chodorow-Reich, G. 2013. The Employment Effects of Credit Market Disruptions: Firm-level Evidence from the 2008–9 Financial Crisis *. *The Quarterly Journal of Economics* 129:1–59. ISSN 0033-5533. doi:10.1093/qje/qjt031.

Chow, A. 2023. More than 85% of Silicon Valley Bank's deposits were not insured. Here's what that means for customers. *Time Magazine* Online: https://time.com/6262009/silicon-valley-bank-deposit-insurance/.

Coles, J. L., N. D. Daniel, and L. Naveen. 2013. Calculation of compensation incentives and firm-related wealth using Execucomp: Data, program, and explanation. doi:https://dx.doi.org/10.2139/ssrn.2296381. SSRN working paper.

Cookson, J. A., C. Fox, J. Gil-Bazo, J. F. Imbet, and C. Schiller. 2023. Social media as a bank run catalyst. doi:http://dx.doi.org/10.2139/ssrn.4422754. SSRN Working paper.

Delevingne, L. 2023. How First Republic's courtship of the wealthy led to meltdown. *Reuters* Online: https://www.reuters.com/business/finance/how-first-republics-courtship-wealthy-led-meltdown-2023-03-27.

Diamond, D. W., and P. H. Dybvig. 1983. Bank runs, deposit insurance, and liquidity. *Journal of Political Economy* 91:401–19. doi:10.1086/261155.

DiCamillo, N. 2021. Signature Bank crosses $10b in deposits from crypto customers. *Coindesk Reports* Online: https://www.coindesk.com/business/2021/01/21/signature-bank-crosses-10b-in-deposits-from-crypto-customers.

Dimson, E. 1979. Risk measurement when shares are subject to infrequent trading. *Journal of Financial Economics* 7:197–226. ISSN 0304-405X. doi:https://doi.org/10.1016/0304-405X(79)90013-8.

Drechsler, I., A. Savov, and P. Schnabl. 2017. The deposits channel of monetary policy. *The Quarterly Journal of Economics* 132:1819–76. ISSN 0033-5533. doi:10.1093/qje/qjx019.

———. 2021. Banking on deposits: Maturity transformation without interest rate risk. *The Journal of Finance* 76:1091–143. doi:https://doi.org/10.1111/jofi.13013.

Drechsler, I., A. Savov, P. Schnabl, and O. Wang. 2023. Banking on uninsured deposits. doi:http://dx.doi.org/10.3386/w31138. NBER working paper.

Egan, M., A. Hortaçsu, and G. Matvos. 2017. Deposit competition and financial fragility: Evidence from the us banking sector. *American Economic Review* 107:169–216. doi:10.1257/aer.20150342.

Egan, M., S. Lewellen, and A. Sunderam. 2021. The cross-section of bank value. *The Review of Financial Studies* 35:2101–43. ISSN 0893-9454. doi:10.1093/rfs/hhab089.

Eisen, B., A. Ackerman, and C. Driebusch. 2023. First Republic Bank is a problem with no easy solution. *The Wall Street Journal* Online: https://www.wsj.com/articles/first-republic-is-a-problem-with-no-easy-solution-9c2525b6.

English, W. B., S. J. Van den Heuvel, and E. Zakrajšek. 2018. Interest rate risk and bank equity valuations. *Journal of Monetary Economics* 98:80–97. ISSN 0304-3932. doi:https://doi.org/10.1016/j.jmoneco.2018.04.010.

Goldstein, I., and A. Pauzner. 2005. Demand–deposit contracts and the probability of bank runs. *The Journal of Finance* 60:1293–327. doi:https://doi.org/10.1111/j.1540-6261.2005.00762.x.

Gompers, P. 2023. Silicon Valley Bank's focus on startups was a double-edged sword. *Harvard Business Review* Online: https://hbr.org/2023/03/silicon-valley-banks-focus-on-startups-was-a-double-edged-sword.

Haddad, V., B. Hartman-Glaser, and T. Muir. 2023. Bank fragility when depositors are the asset. doi: https://dx.doi.org/10.2139/ssrn.4412256. SSRN working paper.

Hayes, D. 2023. SVB, Signature racked up some high rates of uninsured deposits. *S&P Global Market Intelligence* Online: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/svb-signature-racked-up-some-high-rates-of-uninsured-deposits-74747639.

Hutchison, D. E., and G. G. Pennacchi. 1996. Measuring rents and interest rate risk in imperfect financial markets: The case of retail bank deposits. *Journal of Financial and Quantitative Analysis* 31:399–417–. doi:10.2307/2331398.

Ibbotson, R. G., P. D. Kaplan, and J. D. Peterson. 1997. Estimates of small-stock betas are much too low. *Journal of Portfolio Management* 23:104–11.

Ip, G. 2023. SVB-fueled turmoil junks lessons of the global financial crisis. *The Wall Street Journal* Online: https://www.wsj.com/articles/svb-fueled-turmoil-junks-lessons-of-the-global-financial-crisis-e3240816.

Iyer, R., and M. Puri. 2012. Understanding bank runs: The importance of depositor-bank relationships and networks. *American Economic Review* 102:1414–45. doi:10.1257/aer.102.4.1414.

Iyer, R., M. Puri, and N. Ryan. 2016. A tale of two runs: Depositor responses to bank solvency risk. *The Journal of Finance* 71:2687–726. doi:https://doi.org/10.1111/jofi.12424.

Jiang, E. X., G. Matvos, T. Piskorski, and A. Seru. 2023a. Limited hedging and gambling for resurrection by U.S. banks during the 2022 monetary tightening. doi:http://dx.doi.org/10.2139/ssrn.4410201. SSRN working paper.

———. 2023b. Monetary tightening and U.S. bank fragility in 2023: Mark-to-market losses and uninsured depositor runs? doi:http://dx.doi.org/10.3386/w31048. NBER working paper.

Johnson, K., J. Rosenblatt, and C. Dolmetsch. 2023. SVB's lack of risk officer emerges as focus in fed probe. *Bloomberg* Online: https://www.bloomberg.com/news/articles/2023-03-14/svb-s-lack-of-risk-officer-emerges-as-focus-for-fed-lawyers.

Koont, N., T. Santos, and L. Zingales. 2023. Destabilizing digital "bank walks". doi:http://dx.doi.org/10.2139/ssrn.4443273. SSRN Working paper.

Martin, C., M. Puri, and A. Ufier. 2023. Deposit inflows and outflows in failing banks: The role of deposit insurance. *Journal of Finance* Forthcoming.

Meiselman, B. S., S. Nagel, and A. Purnanandam. 2020. Judging banks' risk by the profits they report. doi:http://dx.doi.org/10.2139/ssrn.3169730. SSRN working paper.

Moritz, M. 2023. SVB provided for tech when everyone else ignored us. *Financial Times* Online: https://www.ft.com/content/e8926841-88ff-4cf5-8c45-4d1879f7ff4b.

Paravisini, D., V. Rappoport, and P. Schnabl. 2023. Specialization in bank lending: Evidence from exporting firms. *The Journal of Finance* 78:2049–85. doi:https://doi.org/10.1111/jofi.13254.

Salmon, F. 2023. Why failed Silicon Valley Bank was an outlier. *Axios* Online: https://www.axios.com/2023/03/15/silicon-valley-bank-outlier-uninsured-deposits.

Stokes, S., S. Palazzolo, A. Joyner, B. Chan, and C. Johnson. 2023. Startups that use Silicon Valley Bank are freaking out overwhether they'll make next week's payroll: 'our money is gone'. *Insider* Online: https://www.businessinsider.com/startups-silicon-valley-bank-worried-wont-pay-employees-next-week-2023-3.

Warmbrodt, Z. 2023. Elizabeth Warren, J.D. Vance team up on bank CEO showdown. *Politico* Online: https://www.politico.com/news/2023/06/01/warren-vance-failed-banking-crackdown-bill-00099579.

Weil, J. 2023. Declines in loan values are widespread among banks. *The Wall Street Journal* Online: https://www.wsj.com/articles/declines-in-loan-values-are-widespread-among-banks-c3ee622f.

Appendix A Mathematical Proofs

A.1 Proof for Proposition 1

Proof. Observe from Equation 6, $W(R, \rho_u, b)$ is independent of b given (R, ρ_u), we thus use $W(R, \rho_u)$ denote the promised payoff to the depositors under (R, ρ_u).

According to Equation 8, we have $V(b, D) = D \max_s v(b, s)$,where

$$v(b, s) \equiv (v_h - v_l)\, r_f + \hat{\chi}(b, s)\alpha(b) - r_f \xi(\hat{\chi}(b, s)) - s\left(\frac{W^* - (1 + \rho_0)d_u}{d_u}\right). \tag{A.1}$$

Thus, $s^*(b)$ is independent of D. Hence, the equilibrium allocation and payoff $\{s^*(b), W^*\}$ must be such that for all $s^*(b) > 0$, FOC 9 holds.

That is, given W^*, the marginal benefit and cost of adding one uninsured depositor is equalized for all active banks. If this condition does not satisfy, a bank can lower (raise) W in order to attract less (more) UD. Lastly, since $v_{ss}(b, s) \propto -r_f \xi''(\chi(b, s)) < 0$, it means that $s^*(b)$ that satisfies Equation 9 is unique.

To guarantee the interior solutions, where uninsured depositors allocate across different banks, we assume that

$$\lambda(1 - F(b^H z))\alpha(b^H) - r\xi'\left(\lambda(1 - F(b^H z))\frac{1}{d_u}\right) < 0$$

That is, for the most informed bank b^H, the cost of capital is high enough so that it is not optimal to have uninsured depositors only. That is, together with the fact that $\xi'(0) = 0$, it means that there must be some uninsured depositors in other bank $b < b^H$ in equilibrium. Equation 10 can be derived by differentiating Equation 9 with respect to b. The market clearing condition of $s^*(b, D)$ implies that

$$\int s^*(b) D\, g(b, D)\, db\, dD = d_u.$$

■

A.2 Proof for Proposition 2

Proof. Equation 10 implies that $\frac{ds^*(b)}{db} > 0$. The measure of uninsured depositors $\mu^*(b, D) = D\left\{\frac{\chi^*(b)}{\lambda(1-F(bz))}\right\}$ also increases in b, as $1 - F(bz)$ decreases in b. Lastly, since

$$V^*(b, D) = \max_s Dv(b, s),$$

we thus have $\frac{dV^*(b,D)}{db} = Dv_b(b, s^*(b)) > 0$. ■

A.3 Proof for Proposition 3

Proof. Let $\theta \equiv \frac{\sigma}{r_f}$ and $s^*(b|\theta)$ denote the allocation under θ. First of all, for any $\theta' > \theta$, it must be the case that $s^*(b|\theta)$ and $s(b|\theta')$ only cross once at $\hat{b}$, otherwise it must violate market-clearing condition. Moreover, observe that From Equation 10 $\frac{ds^*(b)}{db}$ increases with θ, hence, at any point when these two functions cross, it must be the case that $\frac{ds^*(b|\theta')}{db} > \frac{ds^*(b|\theta)}{db}$. In other words, $s^*(b|\theta')$

must cross cross $s^*(b|\theta)$ from below, and thus these two functions can cross at most once. Thus, we have $s^*(b|\theta') > s^*(b|\theta')$ iff $b > \hat{b}$. ∎

To understand the effect of interest rate, we first establish that, without any reallocation (i.e., fixing θ), $\upsilon^*(b,\theta) \equiv \frac{v^*(b)}{r_f}$ remains constant. Then, we show that a decrease in θ results in a larger drop for the more informed banks, where the change in the valuation is defined as $\Delta(b) \equiv \upsilon^*(b,\theta') - \upsilon^*(b,\theta)$.

Lemma A1. *(Scaling effect w.o reallocation) Conditional on the ratio of $\theta \equiv \frac{\sigma}{r_f}$, the payoffs of all agents are scaled by the risk-free rate. That is, if $\tilde{r}_f = \gamma r_f$ and $\tilde{\sigma} = \theta \tilde{r}_f, \tilde{\rho}_u = \gamma \rho_u, \tilde{R} = \gamma R, \tilde{V}(b) = \gamma V(b)$ and $\Delta(b) = 0\ \forall b$.*

Proof. Note that $\chi^*(b)$ remains the same conditional on $\frac{\sigma}{r_f}$. Let $\omega^* \equiv \frac{W^* - (1+\rho_0)d_u}{d_u}$, Banks' valuation can thus expressed as

$$\begin{aligned} v(b, s^*(b)) &= r_f(\nu_h - \nu_l) + \chi(b, s^*(b)) \left(\frac{1 - F(z)}{1 - F(bz)} 2\sigma - (\sigma + \nu_h r_f) \right) - r_f \xi(\chi(b, s^*(b))) - s^*(b)\omega^* \\ &= r_f \left((\nu_h - \nu_l) + \chi(b, s^*(b)) \left(\frac{1 - F(z)}{1 - F(bz)} 2\frac{\sigma}{r_f} - (\frac{\sigma}{r_f} + \nu_h) - \xi(\chi(b, s^*(b))) \right) - s^*(b)\frac{\omega^*}{r_f} \right) \end{aligned}$$

Since ρ_0 is scaled with r_f ($\rho_0 = \nu_l r_f$), by guess and verify, one can see that ω^*,ρ_u and R is also scaled with r_f and $\frac{v(b,s^*(b))}{r_f}$ is the same conditional on $\theta = \frac{\sigma}{r_f}$. ∎

Lemma A2. *(Distributional effect under reallocation) For $\theta' < \theta$, $\upsilon^*(b,\theta') - \upsilon^*(b,\theta) < 0\ \forall b > \hat{b}$ and $\upsilon^*(b,\theta') - \upsilon^*(b,\theta) > 0$ for $b < \hat{b}$. Moreover, $\Delta(b') < \Delta(b) < 0\ \forall b' > b > \hat{b}$.*

Proof. Given $\theta' < \theta$, there exists $\hat{b}$ such that $\chi^*(\hat{b})$ remains the same. Moreover, one can show that $\frac{v(\hat{b},\chi^*(\hat{b}))}{r_f}$ remains the same as well, as

$$\frac{v(\hat{b}, \chi^*(\hat{b}))}{r'_f} - \frac{v(\hat{b}, \chi^*(\hat{b}))}{r_f} = \chi^*(\hat{b}) \left\{ \left(\frac{1 - F(z)}{1 - F\left(\hat{b}z\right)} 2\left(\theta' - \theta\right) - \left(\theta' - \theta\right) \right) - \frac{1}{\lambda(1 - F(bz))} \left(\frac{\omega^*_{\theta'}}{r'_f} - \frac{\omega^*_{\theta}}{r_f} \right) \right\} = 0,$$

where we use the fact that

$$\lambda\left(1 - F(z)\right) 2\theta' - \lambda(1 - F(\hat{b}z)(\theta' + \upsilon_h) - \lambda(1 - F(\hat{b}z))\xi'(\chi^*(\hat{b})) = \frac{\omega^*}{r_f} \tag{A.2}$$

must hold for θ and θ' for $\hat{b}$. In other words, let $\omega^*(\theta) \equiv \frac{w^*}{r_f}$ denote the equilibrium payoff to uninsured depositors relative to risk-free rate under θ, we have

$$\omega^*_\theta(\theta) = \lambda\left(1 - F(z) + \left(F(\hat{b}z) - F(z)\right)\right) > 0.$$

That is, the change in $\omega^*(\theta)$ offsets the change in $\alpha(\hat{b})$ at the bank $\hat{b}$ so that bank $\hat{b}$ takes the same amount of risk $\chi^*(\hat{b})$. Bank's profits can be expressed as

$$\upsilon^*(b,\theta) = \max_{\chi} \left((\nu_h - \nu_l) + \chi \left(\frac{1 - F(z)}{1 - F(bz)} 2\theta - (\theta + \nu_h) - \xi(\chi) \right) - \frac{\chi}{\lambda(1 - F(bz))}\omega^*(\theta) \right),$$

hence, by Envelope theorem, we have

$$\begin{aligned}\upsilon_\theta^*(b,\theta) &= \chi^*(b)\left(2\frac{1-F(z)}{1-F(bz)}-1\right)-\frac{\chi^*(b)}{\lambda(1-F(bz))}\omega_\theta^*(\theta)\\ &= \chi^*(b)\left\{\left(2\frac{1-F(z)}{1-F(bz)}-1\right)-\left\{2\frac{(1-F(z))}{(1-F(\hat{b}z))}2-1\right\}\right\},\end{aligned}$$

which is positive if and only if $b > \hat{b}$. Hence, a decrease in θ means lower (higher) $\frac{\upsilon^*(b)}{r_f}$ if and only if $b > \hat{b}$.

Moreover, for $b > \hat{b}$, we thus have

$$\frac{\upsilon^*(b)}{r_f} = \frac{\upsilon^*(\hat{b})}{r_f} + \int_{\hat{b}}^{b} \frac{\upsilon_b^*(\tilde{b})}{r_f} d\tilde{b} = \frac{\upsilon^*(\hat{b})}{r_f} + \int_{\hat{b}}^{b} \chi^*(\tilde{b})\frac{\alpha_b(\tilde{b})}{r_f} d\tilde{b},$$

where, by the envelope theorem, we have $\frac{\upsilon_b^*(\tilde{b})}{r_f} = \frac{\chi^*(\tilde{b})\alpha_b(\tilde{b})}{r_f} = \chi^*(\tilde{b})\frac{F'(bz)z(1-F(z))}{(1-F(bz))^2}2\theta$.

Hence,

$$\Delta(b) = \int_{\hat{b}}^{b} \left(\chi_{\theta'}^*(\tilde{b})\theta' - \chi_\theta^*(\tilde{b})\theta\right)\left(\frac{F'(\tilde{b}z)z(1-F(z))}{\left(1-F\left(\tilde{b}z\right)\right)^2}\right) d\tilde{b}' < 0$$

and for any $b' > b \geq \hat{b}$ and $\theta' < \theta$, as $\chi_{\theta'}^*(b) - \chi_\theta^*(b) < 0$. We thus have

$$\Delta(b') - \Delta(b) = \int_{b}^{b'} \left(\chi_{\theta'}^*(\tilde{b})\theta' - \chi_\theta^*(\tilde{b})\theta\right)\left(\frac{F'(\tilde{b}z)z(1-F(z))}{\left(1-F\left(\tilde{b}z\right)\right)^2}\right) d\tilde{b} < 0.$$

■

Lemma A1 establishes the scaling effect, fixing the ratio of $\theta \equiv \frac{\sigma}{r_f}$. Thus, in Proposition 3, we focus on the change in the scaled profits, which follows from Lemma A2.

Table 1: Summary Statistics

This table reports summary statistics for our cross-section of regional banks. Data sources are bank call reports, CRSP daily and monthly stock files, ExecuComp, and RiskMetrics.

Variable	Units	Mean	Stdev	Median	25th pct.	75th pct.	N
A. Basic characteristics							
Start of 2022							
Uninsured deposits	Fraction	0.55	0.14	0.54	0.46	0.63	179
Assets	$ billions	21.7	51.5	7.2	3.4	19.6	179
Deposits	$ billions	18.8	44.3	6.0	2.9	16.2	179
Market cap	$ billions	3.2	7.8	1.1	0.4	3.0	179
Illiquidity ratio	%/$1MM flow	1.5	2.1	0.5	0.1	2.1	179
Days with no trade	%	1.1	1.1	0.8	0.4	1.6	179
2017-2021 Average							
Uninsured deposits	Fraction	0.48	0.14	0.46	0.38	0.56	179
Assets	$ billions	15.7	35.1	5.4	2.5	14.2	179
Deposits	$ billions	12.9	28.9	4.5	2.1	11.5	179
Market cap	$ billions	2.2	4.9	0.8	0.3	2.3	179
B. Price-based risk, 2022-onward							
Return, Mar 8-13 2023	%	-15.5	11.3	-13.1	-16.9	-9.9	179
Average return	%, annualized	-20.3	25.6	-15.6	-28.2	-7.2	179
Return volatility	%, annualized	31.6	11.8	28.7	25.7	32.9	179
Beta	Sensitivity	0.59	0.33	0.51	0.39	0.69	179
Rate beta	Sensitivity	-2.70	2.48	-2.34	-3.75	-1.22	179
C. Price-based risk, pre-2022							
Average return	%, annualized	9.0	6.9	7.6	4.6	11.7	179
Return volatility	%, annualized	28.9	5.5	28.2	24.7	31.1	179
Beta	Sensitivity	0.99	0.35	0.96	0.75	1.24	179
Rate beta	Sensitivity	26.03	7.52	25.66	20.79	30.71	179
D. Profitability, valuation, deposits							
Return on equity, pretax	%	14.3	3.9	13.6	11.8	16.4	179
Return on assets, pretax	%	1.6	0.4	1.6	1.3	1.8	179
Market equity / book equity	Ratio	1.33	0.39	1.25	1.10	1.44	179
Market assets / book assets	Ratio	1.04	0.04	1.03	1.01	1.05	179
C&I loans / assets	Fraction	0.13	0.07	0.11	0.07	0.17	179
Non-personal / total IPC deposits	Fraction	0.43	0.16	0.41	0.32	0.51	162
Deposit growth, quarterly	Log points	0.04	0.02	0.03	0.02	0.04	179

Table 1, continued.

Variable	Units	Mean	Stdev	Median	25th pct.	75th pct.	N
E. Balance sheet risk							
Common equity tier 1 capital	%	13.1	2.9	12.5	11.7	13.7	178
Tier 1 capital	%	13.2	2.9	12.6	11.8	13.7	178
Total capital	%	14.2	3.0	13.5	12.8	14.8	178
Leverage ratio	%	10.2	2.1	9.8	9.2	10.7	179
Maturity gap	Years	3.5	1.6	3.2	2.2	4.2	179
DV01	% of CET1	0.29	0.18	0.26	0.15	0.40	179
Interest rate swap usage	Indicator	0.7	0.4	1.0	0.4	1.0	157
F. Compensation and governance							
Avg total compensation (top 5)	$ Thousands	1870.8	1165.5	1541.0	1075.7	2245.4	73
Total insider ownership (top 5)	%	1.4	1.5	1.0	0.5	1.4	73
Board independence	%	82.5	7.7	85.6	77.5	88.2	63
Average indep-director ownership	%	0.2	0.3	0.1	0.0	0.2	63

Table 2: Price-based risk, January 2022-March 2023

This table reports estimates of ordinary least square (OLS) regressions where the left-hand-side variables are stock returns and realized risk measured over January 2022-March 2023 and where the right-hand-side variables are the uninsured deposit fraction and control variables as of the end of 2021. Control variables include log assets and quintile indicators for Amihud (2002) illiquidity and the frequency of days with no trade. We measure all left-hand-side variables using daily returns and calculate sensitivities using the Dimson (1979) method, requiring 80% of possible observations in the period. The column headers indicate the left-hand-side variable of each regression. The four-day return in column 1 represents the return from March 8-13, 2023, inclusive, and is not annualized. The average return and volatility in column 2 are annualized. Robust standard errors are reported in brackets. */**/*** indicates significant at the 10%, 5% and 1% levels, respectively.

	4-Day Return (1)	Average Return (2)	Volatility (3)	Beta (4)	Rate beta (5)
UNINS	-35.350	-67.914	22.868	0.505	-3.541
	[7.141]***	[18.671]***	[8.163]***	[0.207]**	[1.715]**
N	179	179	179	179	179
R^2	0.432	0.257	0.398	0.507	0.265

Table 3: Price-based risk, 2017-2021

This table reports estimates of ordinary least square (OLS) regressions where the left-hand-side variables are stock returns and risk and the right-hand-side variables are the average uninsured deposit fraction and control variables, all measured over 2017-2021. We measure all left-hand-side variables using monthly returns and require 80% of possible observations in the period. Control variables include log of 5-year average assets, quintile indicators for Amihud (2002) illiquidity, and quintile indicators for the frequency of no-trade days. We measure the latter two variables using daily returns from 2017-2021. The column headers indicate the left-hand-side variable of each regression. */**/*** indicates significant at the 10%, 5% and 1% levels, respectively.

	Average Return (1)	Volatility (2)	Beta (3)	Rate beta (4)
UNINS	8.489	8.829	0.726	10.552
	[5.446]	[3.772]**	[0.167]***	[4.491]**
N	179	179	179	179
R^2	0.099	0.184	0.487	0.300

Table 4: Profitability, valuation, and deposits

This table reports estimates of ordinary least square (OLS) regressions where the left-hand-side variables are profitability and valuation measures, as well as annual deposit growth, and the right-hand-side variables are the average uninsured deposit fraction and log of average assets, all measured as averages over 2017-2021. We measure annual ROE, ROA, and valuation ratios at the BHC level from Compustat and other variables at the quarterly bank level from the call reports. For annual Compustat variables, we take the last fiscal year value during each calendar year. The column headers indicate the left-hand-side variable of each regression. */**/*** indicates significant at the 10%, 5% and 1% levels, respectively.

	ROE	ROA	ME/BE	MA/BA	C&I Loans	Non-pers IPC dep.	Deposit Growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UNINS	0.076	0.006	0.586	0.051	0.116	0.594	0.024
	[0.029]**	[0.003]**	[0.269]**	[0.026]*	[0.047]**	[0.111]***	[0.010]**
N	179	179	179	179	179	162	179
R^2	0.064	0.036	0.041	0.028	0.092	0.321	0.038

Table 5: Balance sheet risk

This table reports estimates of ordinary least square (OLS) regressions where the left-hand-side variables are regulatory capital measures (columns 1-4), the maturity gap measured using the English et al. (2018) method, the DV01 measure described in the text, and an indicator for whether the bank has a positive notional value of interest rate swaps. The right-hand-side variables are the uninsured deposit fraction and log of assets. All variables are measured as averages (or the log of averages) over 2017-2021. The column headers indicate the left-hand-side variable of each regression */**/*** indicates significant at the 10%, 5% and 1% levels, respectively.

	CET1	T1	Total Capital	Leverage	Maturity Gap	DV01 / CET1	IR Swap Indicator
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
UNINS	-0.020	-0.020	-0.016	-0.001	-2.335	-0.291	-0.358
	[0.015]	[0.015]	[0.016]	[0.011]	[0.866]***	[0.102]***	[0.240]
N	178	178	178	179	179	179	157
R^2	0.015	0.011	0.006	0.000	0.044	0.043	0.168

Table 6: Pay and incentives

Panel A reports estimates of ordinary least square (OLS) regressions where the left-hand-side variables are the average top-5 executive pay (TDC1), total ownership by top-5 executives, the fraction of board that is independent, and the average independent director ownership. Right-hand-side variables are the average uninsured deposit fraction and log of average assets. Both left- and right-hand-side variables are measured over 2017-2021. Panel B reports estimates of OLS regressions where the left-hand-side variables are stock returns and risk and the right-hand-side variables are the average (across time) of average (across executives) top-5 executive pay and control variables, all measured over 2017-2021. We measure all left-hand-side variables using monthly returns and require 80% of possible observations in the period. Control variables include log of 5-year average assets, quintile indicators for Amihud (2002) illiquidity, and quintile indicators for the frequency of no-trade days. We measure the latter two variables using daily returns from 2017-2021. Data on executives comes from ExecuComp while data from directors comes from Institutional Shareholder Services, and for this data we take the last fiscal year value during each calendar year. We include the CEO in our top-5 calculation even if the CEO does not belong to the top-5 executives ranked by total pay. The column headers indicate the left-hand-side variable of each regression. */**/*** indicates significant at the 10%, 5% and 1% levels, respectively.

A: Pay vs uninsured deposits

	Exec Comp	Exec Ownshp	Indep. Directors	Max IndD Ownshp
	(1)	(2)	(3)	(4)
UNINS	0.315	0.036	-0.073	0.024
	[0.260]	[0.014]**	[0.074]	[0.014]
N	73	73	63	63
R^2	0.796	0.172	0.020	0.170

B: Risk vs pay

	Average Return	Volatility	Beta	Rate beta
	(1)	(2)	(3)	(4)
Top5Pay	1.996	9.644	0.450	12.816
	[3.864]	[2.985]***	[0.145]***	[3.957]***
N	73	73	73	73
R^2	0.145	0.256	0.379	0.379

Table 7: Model

Panel A reports the target moments we use to calibrate the model using 2017-2021 data. We scale C&I loans in the data by deposits instead of assets to be consistent with the model. Deposit rates equal quarterly deposit interest expense over prior-quarter deposit dollars. Table 1 and the text describe all other variables. Panel B reports the calibrated parameters that we obtain by minimizing the equal-weight sum of squared moment errors.

A: Target moments

Model parameters	Data definition	Data average	Model average
Share of uninsured dollars (s), stdev	Uninsured deposits	0.14	0.14
Share of project loans (χ), mean	C&I loans	0.16	0.17
… standard deviation		0.09	0.05
Ratio of χ/s, mean	C&I loans / Uninsured deposits	0.35	0.35
… standard deviation		0.21	0.0003
ROA (v), mean	ROA, pretax	1.58%	1.58%
… standard deviation		0.39%	0.02%
Deposit rates, mean	Deposit rates	0.70%	0.70%

B: Calibrated parameters

Parameters	Symbol	Value
Upper limit of investment probability	κ_H	0.65
Spread in investment probability	Δ	0.19
Unconditional project loan success rate	Z	0.64
Cost of risk – scale parameter	δ	2.05
Effective investment opportunity	λ^e	0.53
Loan return volatility	σ	9.53%
Return of standard loan (outside option)	r_B	1.17%
Discount factor for insured deposit rate	v_l	0.93

Figure 1: Returns over March 8-13, 2023

This figure plots the cumulative return over March 8-13th, 2023 (vertical axis, non-annualized percentage points, dates inclusive) versus the 2021 fraction of uninsured deposits (horizontal axis, fraction) for 179 publicly traded U.S. regional banks meeting our sample criteria. The plot indicates tickers next to each data point. Data come from CRSP and quarterly bank call reports (FFIEC 031/041). The solid line is the best-fit line, and the dashed line is the best-fit line excluding Silicon Valley Bank.

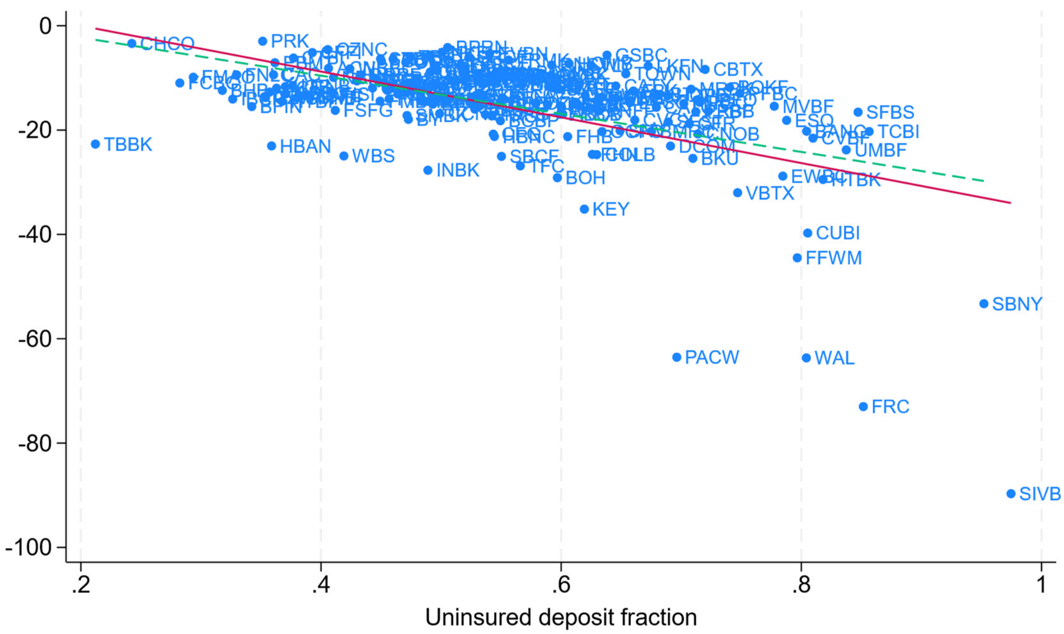


Figure 2: Stock market returns and Treasury yields, 2017-March 2023

This figure plots the cumulative return of the CRSP value-weighted index (left-hand axis, percentage points) and 3-month Treasury yield (right-hand axis, percentage points) from 2017-March 2023.

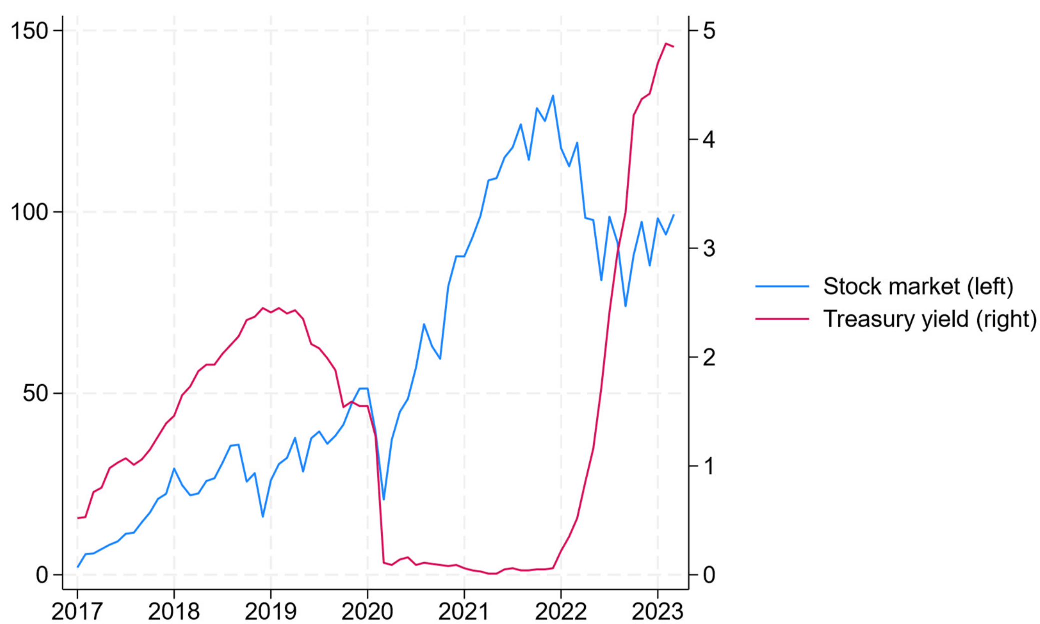
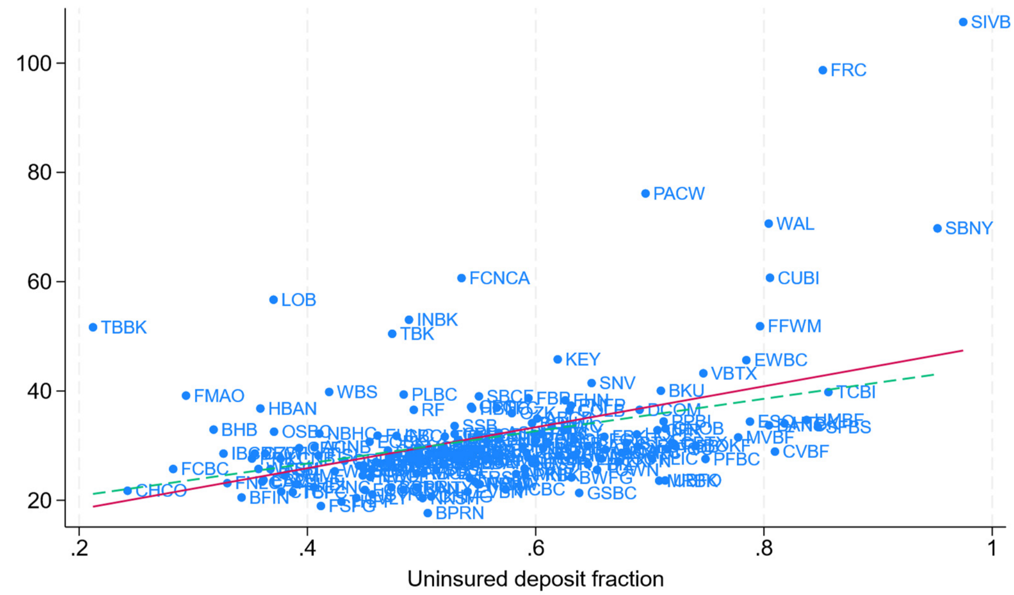


Figure 3: Price-based risk, January 2022-March 2023

This figure plots return volatility (panel A, vertical axis, annualized percentage points) and market beta (panel B, vertical axis) over January 2022-March 2023 versus the uninsured deposit fraction (horizontal axis) measured as of the end of 2021. We measure volatility and beta using daily returns and calculate beta using the Dimson (1979) method, requiring 80% of possible observations in the period. Data come from CRSP and quarterly bank call reports (FFIEC 031/041). The solid line is the best-fit line, and the dashed line is the best-fit line excluding Silicon Valley Bank.

A. Volatility



B. Beta

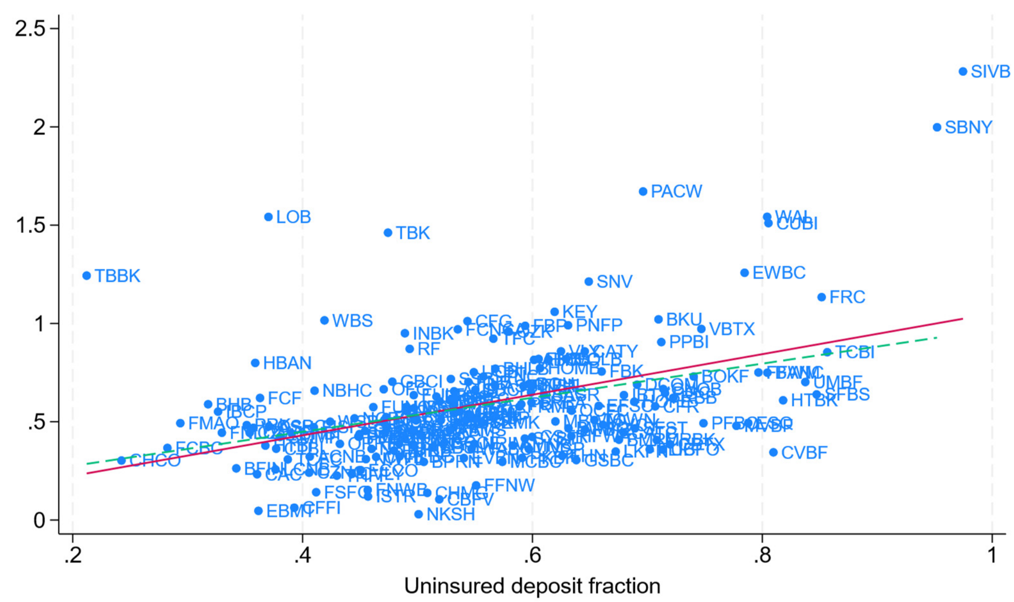
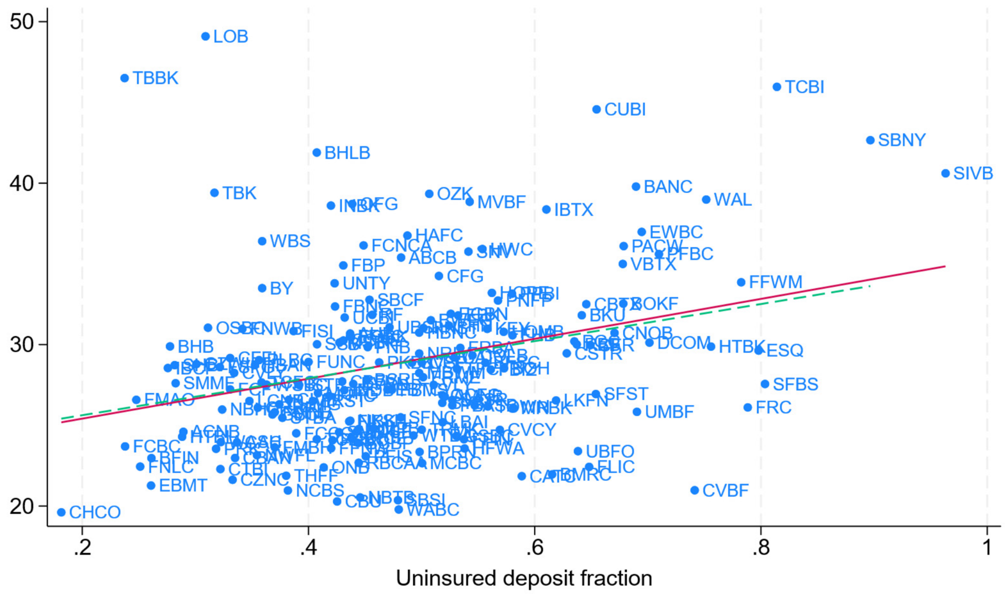


Figure 4: Price-based risk, 2017-2021

This figure plots return volatility (panel A, vertical axis, annualized percentage points) and market beta (panel B, vertical axis) versus the average uninsured deposit fraction (horizontal axis) and control variables, all measured over 2017-2021. We measure volatility and beta using monthly returns and require 80% of possible observations in the period. Data come from CRSP and quarterly bank call reports (FFIEC 031/041). The solid line is the best-fit line, and the dashed line is the best-fit line excluding Silicon Valley Bank.

A. Volatility



B. Beta

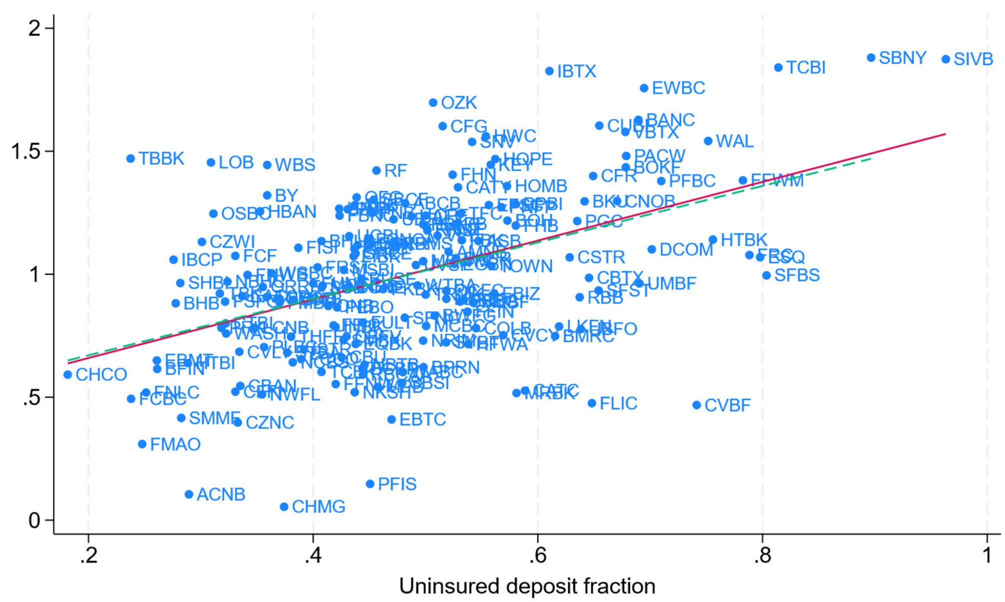


Figure 5: Deposit allocations

This figure plots the ratio of share of uninsured depositors (vertical axis) versus the ranking of bank (horizontal axis). The two lines represent the model-implied deposit allocations. The blue line represents the share under the low-rate regime when interest rates are 0.1%. The dashed orange line represents the share predicted by the model in the high-rate regime when interest rates are 4%. We scale the model-implied values by $\bar{S} = 0.48$. The plot also displays data values for three time periods: 2017-2021 (blue, low-rate regime), 2022 (yellow, high-rate regime excluding 2023), and 2022-2023Q1 (high-rate regime including 2023, excluding failed banks such as SIVB), where we scale values by their within-period means.