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FEDERAL RESERVE BANK of NEW YORK

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Abstract

Why do banks fail? We create a panel covering most commercial banks from 1865 through 2023 to study the history of failing banks in the United States. Failing banks are characterized by rising asset losses, deteriorating solvency, and an increasing reliance on expensive non-core funding. Commonalities across failing banks imply that failures are highly predictable using simple accounting metrics from publicly available financial statements. Predictability is high even in the absence of deposit insurance, when depositor runs were common. Bank-level fundamentals also forecast aggregate waves of bank failures during systemic banking crises. Altogether, our evidence suggests that the ultimate cause of bank failures and banking crises is almost always and everywhere a deterioration of bank fundamentals. Bank runs can be rejected as a plausible cause of failure for most failures in the history of the U.S. and are most commonly a consequence of imminent failure. Depositors tend to be slow to react to an increased risk of bank failure, even in the absence of deposit insurance.

JEL classification: G01, G21, N20, N24
Key words: bank runs, bank failures, financial

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1 Introduction

Bank failures are an inherent feature of banking. In the United States, 20.4% of all national banks in existence from 1863 to 1934 and around 13% of all commercial banks in existence from 1935 to 2023 failed at some point during these periods. Bank failures often lead to real economic disruptions (Bernanke, 1983), and systemic banking crises featuring widespread bank failures are associated with severe macroeconomic downturns (Reinhart and Rogoff, 2009).

What causes bank failures? Theory offers two main explanations for why banks fail. Bank failures can be the consequence of *bank runs* in which depositors collectively withdraw from otherwise solvent (Diamond and Dybvig, 1983) or troubled but solvent banks (Goldstein and Pauzner, 2005). Bank runs are cited as an important cause of bank failures and amplification in prominent accounts of the Great Depression (Friedman and Schwartz, 1963), the 2008 Global Financial Crisis (Bernanke, 2018), and the bank failures in spring 2023. An alternative view is that bank failures are caused by poor *fundamentals* such as realized credit risk, interest rate risk, or fraud, which trigger insolvency irrespective of whether a bank run takes place or not (e.g., Temin, 1976; Wicker, 1996; Calomiris and Mason, 1997; Admati and Hellwig, 2014; Gennaioli and Shleifer, 2018).

This longstanding debate raises several important questions. Which type of failures are empirically most relevant? Are bank failures primarily a result of bank runs or are they more commonly caused by a deterioration of fundamentals? When runs do occur, are they merely a symptom of weak fundamentals or a primary cause of failure?

Understanding the potential determinants of bank failures empirically, however, is challenging. Government interventions such as deposit insurance and lending of last resort reduce the scope for bank runs to cause bank failures in modern times (Metrick and Schmelzing, 2021). A common argument for these interventions is precisely to prevent failures caused by runs, especially on otherwise solvent banks. Thus, observed bank failures in modern times may be biased towards failures involving poor fundamentals.

To overcome this challenge, we study the history of failing banks in the United States from 1865 to 2023. We construct a new database with balance sheet information for most banks in the U.S. since the Civil War. Our data consist of a historical sample that covers all national banks from 1865 to 1941 and a modern sample that covers all commercial banks from 1959 to 2023. Altogether, our data contain balance sheets for around 37,000 distinct banks, of which more than 5,000 fail. This rich sample thus covers failures both before and after the founding of the Federal Reserve System and the introduction of deposit insurance from the Federal Deposit Insurance Corporation (FDIC). Hence, this sample allows us to study bank failures during historical episodes in which bank runs could plausibly have been a common cause of bank failures.

We begin by documenting three facts about commonalities in failing banks which are robust across different institutional settings. First, failing banks see a rise in non-performing loans and deteriorating solvency several years before failure. In failure, banks commonly have large unrealized losses on assets. For example, losses on assets held at failure average 49% in the historical sample, resulting in substantial losses to depositors before deposit insurance. Second, failing banks increasingly rely on expensive and risk-sensitive non-core funding in the run-up to failure. Third, failing banks undergo a boom-and-bust in assets during the decade before failure. Asset losses thus often follow a period of rapid loan growth.

Next, we show that bank failures are remarkably predictable using accounting metrics from publicly available financial statements that indicate deteriorating fundamentals. We first illustrate this by showing that the probability of failure increases in both observable measures of insolvency risk (proxying the distance to default using either bank capitalization, income, or non-performing loans) and funding vulnerabilities (proxying the reliance on expensive and risk-sensitive types of funding such as wholesale deposits or non-deposit wholesale funding). For example, a bank in the top 5$^{\text{th}}$ percentile of both insolvency risk and funding vulnerability has a probability of failure over the next three years of at least 13% and up to 42%, depending on the sample period. This amounts to a 10- to 40-fold increase in the probability of failure relative to the average bank, a large differential.

We quantify the extent of predictability by estimating simple regression models in which we predict whether a bank will fail based on simple measures of a bank's insolvency and funding vulnerability constructed from publicly available financial statements. We assess predictability based on the area under the receiver operating characteristic curve (AUC), a common measure of performance for binary classifiers. In the historical, pre-FDIC sample, the AUC for predicting failure next year is between 83-90%, indicating a high degree of predictability. In the modern sample, after the introduction of deposit insurance, the predictability of bank failures is even higher, with an AUC between 90-95%. In both the historical and modern samples, the predictability of failures is typically nearly as high in pseudo-out-of-sample as in in-sample forecasting exercises.

The high predictability of bank failures extends to failures involving bank runs. We specifically study failures with large deposit outflows, which are indicative of bank runs, and contrast these to failures without large deposit outflows. We first establish that deposit outflows immediately before failure were much larger in the pre-FDIC era. While deposits in failing banks decline on average by around 2% between 1959 and 2023, they fall on average by 12% in the pre-1934 sample. Nonetheless, perhaps surprisingly, we find that even for the pre-FDIC sample period, when depositors typically realized large losses when banks failed, not all failures were preceded by bank runs. In around 25% of failures before 1934, deposits did not decline at all or only minimally. Further, we find that failures with large deposit outflows are at least as easy to predict as failures without large deposit outflows. Hence, banks that exit with a run can be identified as weak banks based on their financial fundamentals before the run happens.

We also study classifications of causes of bank failures provided by contemporary bank examiners from the Office of the Comptroller of the Currency (OCC). Notwithstanding the common occurrence of large deposit outflows in the run-up to failure, from 1865 through 1937, most bank failures were classified by the OCC as being caused by losses, fraud, or external economic shocks. Despite popular narratives about banking panics playing a key role in the historical U.S. banking system, runs and liquidity issues account for less than 2% of failures classified by the OCC.

Weak bank fundamentals not only predict individual bank failures. They also forecast waves of banking failures during systemic banking crises. We aggregate the out-of-sample forecasts of individual bank failure risk to predict the aggregate bank failure rate. The R^2 of a regression of the actual bank failure rate on the predicted aggregate failure rate is 71%. Thus, spikes in bank failures during systemic banking crises cannot merely be explained by panics. Instead, waves of failures are strongly accounted for by deteriorating fundamentals.

In the final part of the paper, we ask: What do the facts we bring forward imply about the causes of bank failures and the nature of banking crises? Are observed bank failures more commonly caused by bank runs or insolvency? It is important to emphasize that our empirical approach does not allow us to identify the causes of individual bank failures definitively. Nonetheless, we can make inferences about the relative importance of runs versus insolvency by contrasting our findings with simple predictions of bank run models.

We make use of the following three predictions of theories of bank runs. First, failures due to bank runs on otherwise solvent banks should at best exhibit a modest degree of predictability (Gorton, 2012; Greenwood et al., 2022). In models of panic runs, bank failures cannot be substantially predictable, as attentive depositors would act on this information and withdraw their funds, reducing the predictability in the first place. Second, for bank runs to represent the cause of bank failure, failing banks should experience large deposit outflows that force them to liquidate their otherwise valuable assets or engage in other activities that erode solvency. Third, recovery rates on assets in failures should be relatively high in failures caused by a run, as banks mostly hold securities and loans that can be separated and repossessed.[1] On the other hand, recovery rates should be low if deteriorating asset quality drives a bank to insolvency irrespective of a run.

Altogether, our findings suggest that the scope for bank runs to represent a common cause of bank failures is limited, even in the absence of deposit insurance. Consider for instance purely self-fulfilling panics as in Diamond and Dybvig (1983). These runs should not be related to fundamentals but strike randomly (see, e.g., Greenwood et al., 2022), feature large deposit outflows before failure, and exhibit relatively low losses in failure. We find that bank failures that were not predicted by bank fundamentals (defined as an out-of-sample predicted probability to fail over a three-year horizon of less than 2.5%), featured large deposit outflows (a decline in deposits of 7.5% before failure), and exhibited relatively modest losses in default (recovery rates in default of above 75%) are extremely rare and make up less than 0.5% of pre-FDIC failures. This fact suggests that Diamond-Dybvig-style bank runs that cause the failure of otherwise healthy banks are unlikely to have been driven into extinction by deposit insurance. Rather, they have never been an empirically relevant cause of bank failures to begin with.

Further, our findings also have implications for the empirical relevance of theories of runs on troubled but solvent banks (Goldstein and Pauzner, 2005; Rochet and Vives, 2004; He and Xiong, 2012). We document that when runs on failing banks do occur, they tend to happen in banks with weak observable fundamentals. Our paper thus generalizes insights from existing empirical studies that have focused on studying specific episodes (see, e.g., Calomiris and Mason, 1997, 2003; Iyer and Puri, 2012) and establishes that weak fundamentals are a necessary condition for a bank run to happen both outside and during financial crises, and both with and without deposit insurance.

[1] The scope of a bank run to destroy value stems mainly from destroying a bank's franchise value rather than reducing the value of assets still held after bank closure. Recent estimates suggest that a bank franchise value is on the order of 20% (Ma and Scheinkman, 2020; Hirtle and Plosser, 2024). Hence, for a bank run to have plausibly been the cause of failure, the recovery rate on assets in failure should not be lower than 80%.

However, we also find that the scope for bank runs to cause the failure of weak but solvent banks is surprisingly limited. Runs on solvent but troubled banks should exhibit low to moderate predictability, large deposit outflows, and moderate losses. However, we find that less than 15% of all pre-FDIC failures fulfill these criteria. In contrast, we find that more than 80% of pre-FDIC failures were characterized by either a high predicted probability of failure (above 7.5%), no deposit outflows, or large asset losses (recovery rates in receivership of less than 50%). Hence, in most bank failures, depositors either did not run, or they withdrew their funds from banks that were most likely already insolvent.

Further, we find that 23% of failures exhibit a very high degree of out-of-sample predicted probability failure over three years of more than 20% in the year before failure. Arguably, any bank with such a high predicted probability of failure cannot be viable if depositors would require compensation for being exposed to such a high risk of bank failure. Thus, the fact that these banks have not failed yet and we as econometricians can observe high predicted failure probabilities suggests that depositors are often slow to react to an increased risk of bank failure. Bank runs, to the extent they happen, seem to happen later than theoretical benchmarks would suggest. This fact, in turn, points to a role for behavioral frictions such as inattentive depositors or neglect of downside risk (e.g., Gennaioli et al., 2012; Jiang et al., 2023).

Taken together, our findings suggest that most bank failures are the result of a deterioration in bank solvency. The erosion of a bank's capitalization ultimately results in either a run or a supervisory decision to close a bank, with the former being more common in the historical data. Importantly, both depositors and supervisors seem to be slow to react to information about bank fundamentals, thus making bank failures highly predictable. Our findings suggest that we can reject bank runs as a plausible cause of failures for a robust majority of banks that failed in the history of the United States.

Related literature. Our paper relates to two strands of literature on bank failures and financial crises.

First, we relate to micro-level studies of bank failures and banking crises, such as empirical studies of the Great Depression (e.g., Calomiris and Mason, 1997, 2003; Mitchener and Richardson, 2019), the 2008 Global Financial Crisis (e.g., Gorton and Metrick, 2012; Krishnamurthy et al., 2014; Schmidt et al., 2016), the recent banking stress in March 2023 (e.g., Jiang et al., 2023), and other episodes featuring bank runs (Iyer and Puri, 2012; Frydman et al., 2015; Iyer et al., 2016; Artavanis et al., 2022).[2] The novelty of our approach is to bring together evidence from roughly 160 years of micro-level data that spans a range of institutional and regulatory regimes. Studying the close-to-complete history of the banking system in the United States allows us to generalize the insight that weak fundamentals are a necessary condition for bank failures across various institutional settings, both during financial crises but also quiet periods. While existing micro-level studies usually condition on a crisis, our long sample demonstrates that failures and banking crises are predictable out-of-sample. Moreover, the richness of the data allows us to provide robust facts about the predictability of bank failures, deposit outflows before failure, and losses realized in failure. Contrasting these facts with testable predictions of bank run models, in turn, establishes that bank runs do not qualify as a plausible cause of failure in the majority of pre-FDIC failures.

Second, our paper is related to studies of financial crises using aggregate data. Within this literature, our paper relates most closely to studies on the nature of banking crises and the sources of bank failures and panics. Gorton (1988) and Calomiris and Gorton (1991) study banking panics in the National Banking Era and find that panics generally

[2]Several of these studies focus on explaining banking failures during specific episodes in the U.S. Calomiris and Mason (2003) find that fundamentals explain bank failures in the Great Depression, rather than panic-driven depositor flight. Using state-level data Alston et al. (1994) find that failures in the 1920s were highest in states that saw the largest growth in agricultural acreage during WWI, and most failing banks were small and rural. Studies using recent Call Report data find that highly levered banks, banks with low earnings, low liquidity, and risky asset portfolios are more likely to fail (Wheelock and Wilson, 2000; Berger and Bouwman, 2013).

followed bad macroeconomic news but were not important for bank failures. Baron et al. (2021) argue that panic runs are not necessary for banking crises, and panics are preceded by bank equity declines, reflecting the realization of bank losses. Our paper provides complementary evidence by using granular bank-level data.[3] This allows us to show that deteriorating fundamentals are necessary for both individual and widespread bank failures, including failures with runs. Moreover, it allows us to provide micro-data evidence that the underlying cause of individual bank failures during systemic banking crises is deteriorating solvency.

The cross-country literature on banking crises finds that rapid credit growth is a robust predictor of systemic banking crises (Borio and Lowe, 2002; Schularick and Taylor, 2012; Baron and Xiong, 2017; Greenwood et al., 2022; Müller and Verner, 2023). We find that rapid asset growth often precedes bank losses and bank failures. Thus, the boom-bust notion documented in earlier studies carries through to the individual bank level (see also Fahlenbrach et al., 2018; Meiselman et al., 2023). Jordà et al. (2020) find that higher banking system capitalization is not associated with a lower chance of banking crises but does predict stronger recovery from crises. Our bank-level findings indicate that higher bank capitalization predicts a lower probability of failure. Moreover, we show that a banking crisis is imminent when a sufficiently large set of banks is subject to deteriorating fundamentals at the same time. Importantly, this implies that micro-data contain information not available in aggregated country-level statistics that allow for the prediction of banking crises.

Roadmap. The paper proceeds as follows. Section 2 describes the data. Section 3 provides new facts about failing banks. Section 4 presents evidence on the predictability of bank failures. Section 5 studies bank failures with and without runs. Section 6 shows that bank-level fundamentals predict the major waves of bank failures in the U.S. Section 7

[3] See Baron et al. (2023) for another recent paper using granular bank-level data to study many banking crises.

discusses how our findings relate to theories of bank failures and banking crises, and Section 8 concludes. Appendix A provides an overview of the evolution of bank failures and the regulatory framework for banks in the U.S. since 1863.

2 Data

Data for historical sample (1865-1941). We use two main data sources on bank balance sheets. Data on national bank balance sheets from 1865 through 1941 are from the Office of the Comptroller of the Currency's (OCC) Annual Report to Congress. For most of the sample, the balance sheets were reported as of September or October of each year, but from 1928 onward the reporting date shifted to the end of each year. The data are quite granular. In addition to broad line items such as total assets, loans, deposits, and equity, for most years banks also report more detailed items that allow us to measure non-performing loans and wholesale funding. However, the OCC did not require banks to report income statements. Figure C.1 and Figure C.2 in Appendix C.1 provide examples of the original source.

Data on all national banks in existence from 1865 until 1904 are digitized and provided by Carlson et al. (2022). For this project, we further digitize bank balance sheets from 1905 through 1941. In both cases, balance sheets are digitized using optical character recognition (OCR), applying the methods discussed in Correia and Luck (2023). We hand-check the OCR output, with particular attention to cases where accounting identities fail to hold and drop observations that violate accounting identities otherwise. Moreover, we compile a list of all significant bank events and their dates—chartering, liquidations, receiverships, etc.—from 1863 to 1935 using data manually collected by van Belkum (1968), augmented by Huntoon (2023), and further validated by the authors using information from the 1941 "Alphabetical List of Banks" (Office of the Comptroller of the Currency, 1941), as well as the corresponding OCC Annual Reports.

We define a national bank as a failed bank whenever a receiver is appointed by the OCC. Note that our definition of failure includes banks that eventually exit receivership and continue operating, and banks that exit receivership and wind down their operations in an orderly voluntary liquidation that imposes no losses to creditors. However, our definition of bank failure excludes bank closures that did not involve a receiver at some point. Moreover, we exclude temporary suspensions in which banks briefly suspend convertibility of their debt into cash and then reopen, as was common during banking panics of the National Banking Era. This implies that we also exclude banks that averted receivership due to cooperation through, for example, bank clearinghouses. We emphasize this distinction, since the factors that lead to bank runs that are resolved by temporary suspension of convertibility may differ from those that lead to bank failures.

The OCC collected detailed information on the post-mortem developments of failing banks. This information is also recorded in the OCC's annual report.[4] These data provide information on the nominal amount of assets and deposits at the moment a bank's business was suspended and a receiver was appointed. Thus, they allow us to calculate the outflow of resources and deposits between the last call report and the failure date. There is also information on asset quality, as the OCC provides estimates of the breakdown of "good," "doubtful," and "worthless" assets at suspension. Furthermore, the data report the funds ultimately collected by the receiver throughout the receivership proceedings. It thus allows us to estimate the recovery rates on assets in failure. The data also contain the recovery rate for depositors. Finally, the OCC classified bank failures by the cause of failure for most failures between 1865 and 1937, with the exception of failures that occurred in 1932 and 1933. Further details on these data are provided in Appendix C.2.

For the period before the founding of the FDIC, we rely entirely on data on national

[4]The OCC annual report from 1920 reports data for all failed national banks from 1863 through 1920 comprehensively. Thereafter, we digitize each OCC's annual report table on national banks in charge of receivers from 1921 through 1939.

banks. The main reason for focusing on national banks is the availability of consistent records provided by the OCC on both balance sheets and bank failures. However, it is important to highlight that the US banking system featured several types of financial institutions that were not chartered under federal law but state law. National banks always coexisted alongside state banks, trusts, and private banks, with the relative importance of each type of institution varying over time. For example, national banks had a market share of the entire banking market ranging from around 80% in the 1870s to around 45% in the 1930s. See Figure A.2 in the Appendix for details on the number and market share of national banks, as well as White (1983).

Data for modern sample (1959-2023). For the modern, contemporary banking system we use the Federal Financial Institutions Examination Council (FFIEC) Consolidated Reports of Condition and Income ("Call Report"). These data provide quarterly information on balance sheets (FFIEC010) and income statements (FFFIEC013) on a consolidated basis for all commercial banks operating in the United States and regulated by the Federal Reserve System (FRS), the FDIC, and the OCC. Note that most existing research based on the Call Report uses the data starting from 1976 onwards. We extend our sample further back to 1959. These data are digitally available at the Federal Reserve from 1959 through 2023. We also merge additional information on bank charters, such as bank founding dates and the primary regulator using the National Information Center (NIC) tables.

We complement the call report data with the FDIC's list of failing banks. This list documents all failures of FDIC member banks from 1934 through 2023 and is available on the FDIC homepage. We define a bank failure as a bank closure.[5] We obtain the failure dates from the list of failing banks. Further, we obtain deposits and total assets at the

[5]Bank closures involve either a purchase of the failing bank with an assumption of some or all of its deposits or a liquidating receivership. Note that the FDICs failure definition is broader. The FDIC defines a bank failure as the closing of a bank by regulators or an instance of open bank assistance. In the former case, the FDIC acts as receiver of the failed bank. In the latter, the FDIC provides financial assistance to prevent failure under a systemic risk exception; the bank would likely have failed without assistance. While we drop the latter, we note that all findings are robust to broadening the failure definition to include open bank assistance.

time of resolution for failures since 1992 from the FDIC's Failure Transaction Database, which we use to calculate deposit and asset growth immediately before failure.

The financial statements we use are at an annual frequency until 1941. After 1959, balance sheets are reported at a biannual frequency before becoming quarterly in 1976. Unless otherwise stated, we use annual data for our analysis to ensure comparability across different eras. We also drop *de novo* banks from the analysis, which we define as banks younger than four years, since the determinants of failure for these banks can be different.[6]

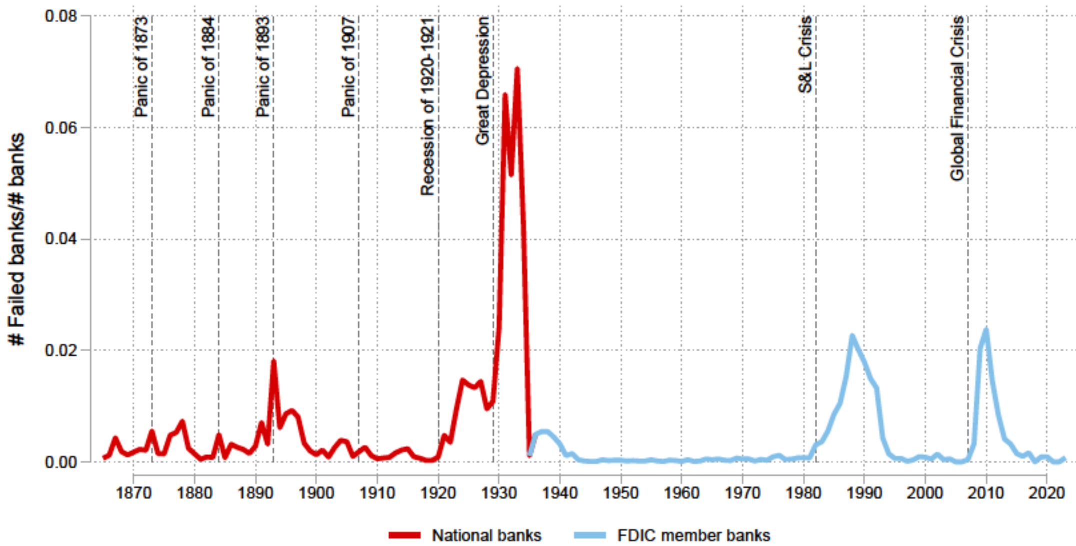
Altogether, our sample consists of 37,498 unique banks.[7] Of these banks, 5,111 banks fail at some point throughout the sample period. Of these failing banks, 2,904 fail before 1935 and 2,207 fail after 1959. Figure 1 plots the rate of bank failures over time. The figure highlights that our sample includes the major financial crises in the history of the U.S., including the Great Depression and the 2008 Global Financial Crisis, as well as many quiet periods when bank failure rates were low. Moreover, our sample covers the period after the founding of the Federal Reserve in 1913 and the founding of the FDIC in 1933, as well as the period before both institutions were operative. Hence, our sample covers an extensive period before the advent of a lender of last resort, deposit insurance, or other forms of government intervention.

Other data. Finally, we use the consumer price index from Global Financial Data to deflate variables that we compare across time. Further, we use aggregate outcomes such as GDP and aggregate credit growth from Jordà et al. (2017) and banking crisis dates from Baron et al. (2021).

[6]The results are very similar when including these banks.

[7]Note that we assign different bank identifies in the OCC data and the Call Report data, thus treating potentially the same bank as different entities before and after Great Depression and the founding of the FDIC. Mechanically, this increases the total number of unique entities.

Figure 1: *Failing Banks, 1865-2023*



Notes: This figure plots the ratio of bank failures to the total number of banks. Vertical lines indicate selected major banking crises and economic downturns. The red line plots the rate of failing national banks, defined as national banks placed into receivership. Figure A.3 in the Appendix shows suspension rates for both national banks and state-chartered institutions. The blue line plots the rate of banks classified as failed by the FDIC. We restrict our sample of FDIC member banks to National Member Banks, State Member Banks, and State Nonmember Banks and exclude Savings Associations, Savings Banks, and Savings and Loans.

3 Three Facts About Failing Banks

This section documents three facts about failing banks over the past 160 years. First, we show that failing banks see gradually deteriorating solvency before failure and large asset losses in failure. Second, failing banks increasingly rely on non-core funding. Third, failing banks follow a boom-bust pattern. Altogether, these facts point to the central role of deteriorating bank fundamentals in bank failures over the past 160 years.

3.1 Losses and solvency dynamics

Fact 1. Failing banks see rising losses and deteriorating solvency before failure.

To study the dynamics in failing banks before their failure, we estimate variants of the following specification:

$$y_{b,t} = \alpha_b + \sum_{j=-10}^{0} \beta_j \times \mathbf{1}_{j=t} + \epsilon_{b,t}, \tag{1}$$

where $y_{b,t}$ is a bank-level outcome, j measures the number of years to failure, and α_b is a bank fixed effect. All variables in levels are deflated by the CPI. Here, we restrict the sample to failing banks that are within 10 years of failure; we compare the dynamics of failing banks to other banks in the next section. We set the benchmark period to be $j = -10$, so all estimates are relative to ten years before failure. The sequence of coefficients $\{\beta_j\}$ captures the dynamics of variable $y_{b,t}$ in the ten years before failure.

We begin by studying the dynamics in indicators of loan losses and solvency in Figure 2. Panel (a) presents evidence for the post-1959 sample. In the five years before failure, there is a 10-percentage point rise in non-performing loans (NPLs). This rise in NPLs translates into rising loan loss provisions, which results in a decline in realized net income. The fall in net income depresses the return on assets by 5 percentage points in the year before failure. As a result, the equity-to-assets ratio declines considerably in the run-up to failure, falling by 10 percentage points.

The patterns in Figure 2a suggest that failures are mainly associated with realized credit risk, rather than a deterioration in the net interest margin (NIM). The NIM is stable in the run-up to failure. In Appendix Figure B.2 we show that failing banks see both rising interest income (indicating higher risk taking) *and* rising interest expenses (in line with higher reliance on expensive forms of funding, as discussed below). Abstracting from valuation effects of holding long-dated fixed-rate securities, the resulting stable NIM suggests that the realization of interest rate risk is not a first-order source of failure for most failing banks. This is consistent with banks engaging in maturity transformation without taking on substantial interest rate risk due to the predominance of interestinsensitive deposit finance (Drechsler et al., 2021).[8]

Panel (b) in Figure 2 illustrates the evolution of proxies for losses in the 1865-1934 sample. In historical accounting data, banks do not provision for losses, so their equity was not immediately impacted when loans became non-performing. However, reported line items in national bank balance sheets allow us to construct several proxies for deteriorating solvency and rising losses. First, we use the ratio of surplus profit to equity to proxy a bank's capitalization.[9] Second, under capital regulation in the National Bank Act, banks would likely face restrictions on dividend payouts when undivided profits fell close to zero (White, 1983).[10] We therefore proxy for low capitalization with an indicator for whether undivided profits fall short of 1% of total bank equity. This measure is available for 1865-1904 and 1929-1934. Third, we proxy for non-performing loans with the balance sheet item "Other Real Estate Owned" (OREO). This item reflects collateral seized and held on a bank's balance sheet, usually following foreclosure, and it is available for 1889-1904.[11]

Figure 2b shows that failing banks see a deterioration in surplus profits relative to equity, indicating declining profitability and capitalization. As a result, there is a 20 percentage point rise in the likelihood that dividend payouts are restricted due to low capitalization. Moreover, non-performing loans as a share of total loans rises gradually by 15 percentage points in the decade before failure, a pattern similar to the finding for the modern sample.

[8]Even restricting to the 1970s and 1980s, we do not find evidence that failing banks experienced deteriorating net interest margins. This is consistent with Wright and Houpt (1996), who find that *thrifts* saw falling NIM in early 1980s, while commercial banks had much more stable NIM. (We thank Sam Hanson for pointing us to this reference.)

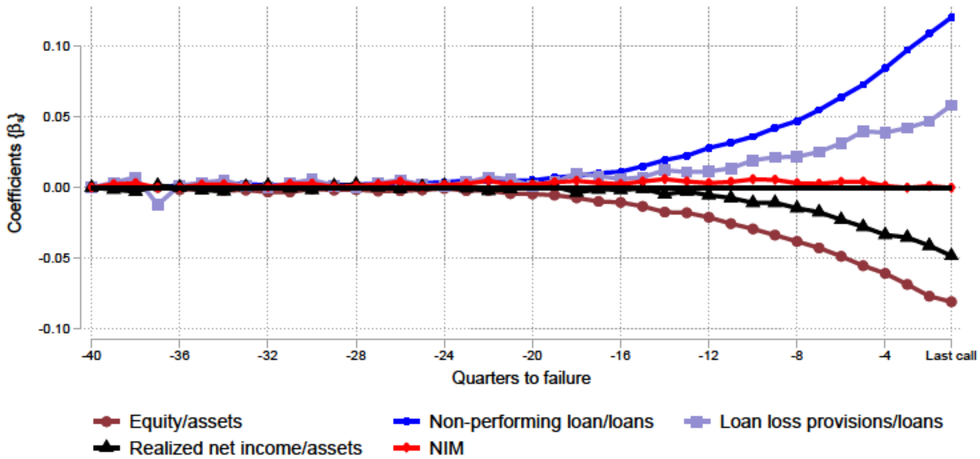
[9]The surplus profit is the sum of the surplus fund and the undivided profits. Capital paid-in was fixed after the founding of a bank and the surplus profit is the portion of equity that was allowed to vary with retained earnings and realized losses.

[10]Fluctuations in bank profitability are reflected in the line item "undivided profits." This item represents funds that could be paid out as dividends to bank shareholders.

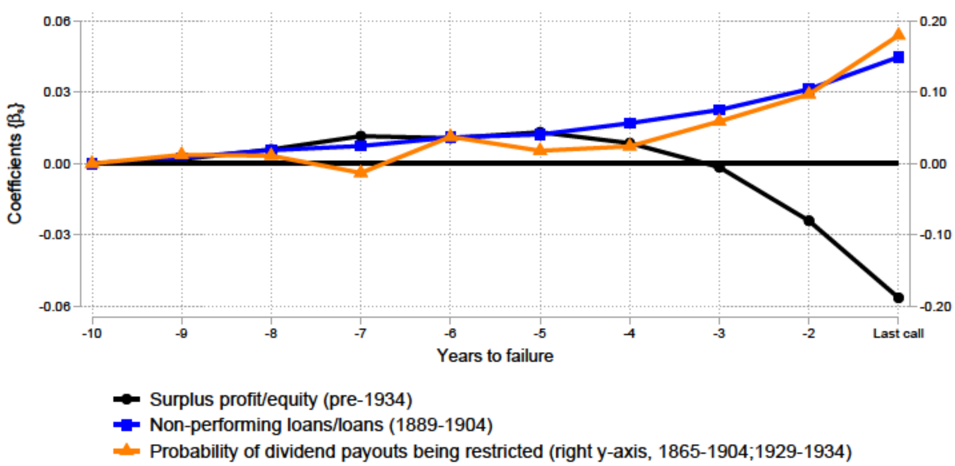
[11]OREO typically refers to real estate property assets that a bank holds but that are not part of its business. Often, these assets are acquired due to foreclosure proceedings and are comparable to seized collateral. In Appendix Figure B.1, we document that OREO as share of loans for failing banks immediately before failure is strongly correlated with the share of assets classified as doubtful or worthless by the OCC in failure.

Figure 2: *Losses and Solvency of Failing Banks: 1865-2023*

(a) *1959-2023*



(b) *1865-1934*



Notes: The figure presents the sequence of coefficients from estimating Equation (1), where the dependent variable is the ratio indicated in the figure legend. The specification includes a set of bank fixed effects. The sample in both panels is restricted to failing banks and the ten years before they fail. In panel (a), the sample is restricted to banks that failed from 1959 through 2023. In panel (b), the sample is restricted to banks that failed from 1865 through 1934. In panel (a), the net interest margin (NIM) is defined as the difference of total interest income net of interest expenses normalized by total assets. In panel (b), surplus profit to equity is the sum of the surplus fund and undivided profits relative to total equity capital (paid-in capital, undivided profits, and surplus fund). Non-performing loans is proxied by the line item "Other real estate owned (OREO)" and is available for the 1889-1904 subsample. Figure B.1 in the Appendix shows that OREO listed in the last call report before failure is strongly correlated with assets classified as doubtful or worthless in failure by the OCC. The probability of dividend payouts being restricted is based on the share of banks with undivided profits of total equity falling short of 1%. This measure captures restrictions on dividend payouts due to low capitalization and is available for 1865-1904 and again after 1929.

Table 1: ***Asset Quality and Recovery Rates in Failure, 1865-1939***

	(1)	(2)	(3)	(4)	(5)	(6)
Era	No. of failures	Assets at suspension			Received after suspension	Ultimate recovery from assets
		Good	Doubtful	Worthless		
1865-1913 (NB Era)	531	0.36	0.40	0.26	0.11	0.45
1914-1928 (Early Fed)	652	0.35	0.40	0.26	0.11	0.48
1929-1934 (Great Depression)	1710	0.36	0.52	0.13	0.08	0.53
All	2893	0.36	0.47	0.18	0.09	0.51

Notes: This table reports estimates of the share of good, doubtful, and worthless assets at the time of suspension, as well as asset recovery rates for failed banks. The sample covers failed national banks from 1865 to 1934. Data are collected from the OCC's annual report to Congress; tables on "National banks in charge of receivers," (various years). Good, doubtful, and worthless assets at suspension are normalized by total assets at suspension. Assets received after suspension (5) and the ultimate recovery from assets (6) are reported as a share of total assets at suspension plus assets received after suspension. The "ultimate recovery from assets" is the total collected funds in receivership relative to total assets. This represents the share of assets that the receiver was ultimately able to recover to compensate debt holders. Note that the receiver also collected funds from shareholders due to double-liability, which increased the overall amount of available funds to distribute to debt holders.

Failing banks in the pre-FDIC period had highly troubled assets and large unrealized asset losses in failure, in line with losses on past investments playing a key role in failures. Table 1 provides statistics on the assets of failing banks at the time of suspension and the ultimate recovery from assets for the 1865-1934 sample. The ultimate recovery from assets represents the value that the receiver was able to obtain from both assets available at suspension and received after suspension. Recovery rates from assets were low in the pre-FDIC sample, averaging 45% to 53%, indicating that many banks were deeply insolvent once they entered receivership.

Further, bank examiners usually judged the assets of failing banks to be highly troubled. The columns "Assets at suspension" in Table 1 indicate estimates of the share of "good," "doubtful," and "worthless" assets provided by the OCC bank examiner at the time of failure. Worthless assets range from 13% to 26% of total assets, depending on the era considered. Doubtful assets represent another 40% to 52%. Table B.3 in the

Appendix shows that asset recovery is well predicted by the bank examiner's assessment of asset quality around the time of failure. On average, one additional dollar of "Good," "Doubtful, and "Worthless" assets resulted in a recovery 78 cents, 45 cents, and 10 cents, respectively. The fact that examiners predicted a low recovery rate for a large part of a failed banks' asset holdings suggests that unrealized losses relative to the book value of assets were potentially a key trigger of failure.[12] That is, while it is in principle possible that values and recovery rates may drop *because* the bank closed, the extent of losses and the fact that examiners identified 64% of assets as having doubtful or worthless value right at the time of suspension suggest that most losses stemmed from past investments going bad.

The low recovery rate on assets in the pre-FDIC sample implies that loss rates for depositors were substantial. Table B.4 in the Appendix presents estimates on the loss rates for uninsured depositors for bank failures in the pre- and post-FDIC samples. Loss rates for uninsured depositors were significantly higher before the founding of the FDIC. In the pre-FDIC sample, 81% of failures involved losses for depositors, and the average unconditional depositor recovery rate (loss rate) is 65% (35%). Moreover, depositors often experienced a substantial delay before receiving their funds. On average, the depositor recovery rate in the initial year is only about 35% (see Figure B.3). In contrast, in the post-FDIC period since 1992, only 20% of failures involved losses for uninsured depositors, and the average unconditional loss rate is 6%.

[12] James (1991) studies 412 bank failures between 1985 and 1988. He finds that asset losses averaged 30% for failing banks. James (1991) argues that a significant portion of these losses reflect past unrealized losses, rather than liquidation discounts. Focusing on bank failures between 1986-2007, Bennett and Unal (2015) find that the average loss amounted to 33.2% of total assets. Further, Granja et al. (2017) show that in the aftermath of the GFC, the average FDIC loss on a failed bank was around 28% of assets, with a substantial part of these losses resulting from frictions in the market for failed banks. Our evidence is broadly consistent with these papers, although we find that the recovery rates were lower in the historical, pre-FDIC sample.

3.2 Funding

Fact 2. Failing banks rely increasingly on non-core funding.

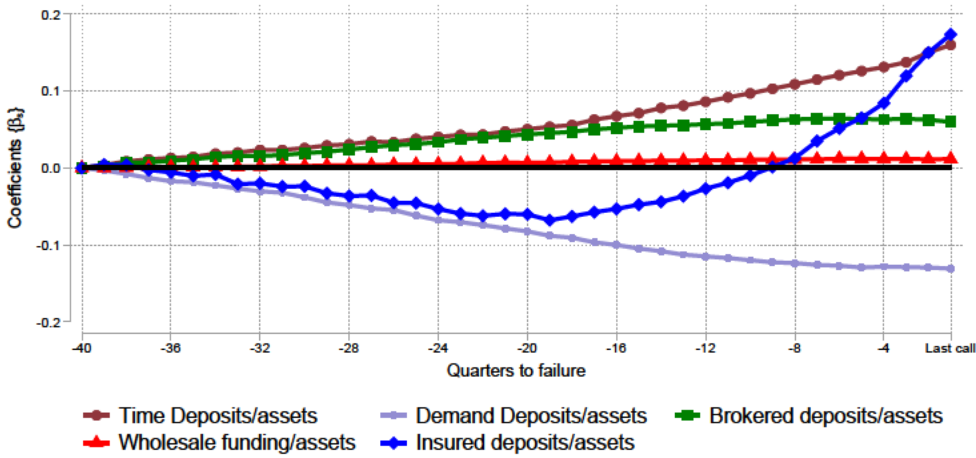
How does bank funding evolve as a bank approaches failure? Figure 3 presents the evolution of various funding ratios in the decade preceding failure. Again, we present results separately for the historical and modern samples, as the detail with which liabilities are reported changes over time.

Panel (a) of Figure 3 presents the results for the post-1959 sample. For this sample, we can distinguish between time, demand, and brokered deposits. Wholesale funding refers to the line item "other borrowed money," which pools market-based funding and funding from the Federal Home Loan Banks (FHLBs) and the Federal Reserve. In the modern sample, failing banks increasingly rely on expensive types of deposit funding. In particular, the largest increase is accounted for by time deposits, followed by brokered deposits. Rates on both time deposits and brokered deposits exhibit a higher sensitivity to changes in the federal funds rate (see, e.g., Drechsler et al., 2017) and are more sensitive to bank risk (see, e.g., Martin et al., 2023). As we show in the next subsection, these expensive sources of non-core funding are often used to finance rapid growth. In contrast, demand deposits decline as a share of assets in the decade before failure. Demand deposits, unlike time or brokered deposits, tend to be held by less price-sensitive retail investors and tend to be a cheaper source of financing. Furthermore, while smaller in absolute terms, failing banks increasingly rely on wholesale funding. Finally, in the modern sample, insured deposits actually flow into failing banks. This suggests that insured depositors do not discipline failing banks, potentially delaying failure.[13]

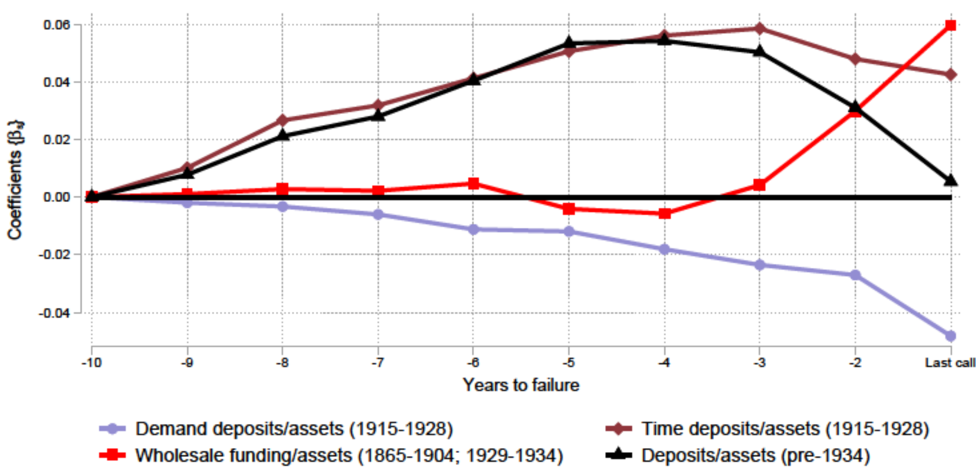
[13] These patterns are consistent with Martin et al. (2023), who find that failing banks increasingly substitute toward expensive deposit funding but also see an inflow of insured deposits before failure. The use of non-core funding to finance rapid growth is consistent with Hahm et al. (2013). Rapid growth financed by brokered deposits before failure is also a feature emphasized in previous research surveyed by FDIC (2011). The FDIC restricts borrowing through brokered deposits for banks that are not well capitalized (i.e., for adequately and undercapitalized banks). Under the FDIC brokered deposit statute dating to 1989, undercapitalized banks may not accept brokered deposits (Section 29 of the Federal Deposit Insurance Act). Given an increased chance of enforcement actions in failing banks growth of brokered deposits thus slows before failure (Martin et al., 2023).

Figure 3: ***Funding of Failing Banks: 1865-2023***

(a) *1959-2023*



(b) *1865-1934*



Notes: This figure shows the sequence of coefficients from estimating Equation (1) for various funding ratios. The sample is restricted to failing banks and the ten years before they fail. In panel (a), the sample is restricted to banks that failed from 1959 through 2023. In panel (b), the sample is restricted to banks that failed from 1865 through 1934. In panel (a), wholesale funding is the amount reported in the call report line item "other borrowed money" which pools various sources of bank wholesale funding, such as advances from Federal Home Loan Banks (FHLBs), other types of wholesale borrowings in the private market, and credit extended by the Federal Reserve. In panel (b), wholesale funding is defined as the sum of "Bills Payable" and "Rediscounts." Time and demand deposits are reported separately for the 1915-1928 subsample.

Panel (b) in Figure 3 presents the evolution of funding ratios for the sample of banks that failed during 1865-1934. We observe total deposits for the entire sample and a breakdown into demand and time deposits for the 1915-1928 subsample. We proxy for wholesale funding using the line items "bills payable" and "rediscounts." Bills payable and rediscounts are forms of short-term, expensive, and secured wholesale funding. Several studies find that banks that experienced difficulties were often forced to rely on this more expensive type of funding (see, e.g., White, 1983; Calomiris and Mason, 1997; Calomiris and Carlson, 2022).

Before 1934, failing banks see an expansion of deposit funding as a share of total assets from ten to four years before failure. As in the modern period, the rise in deposits is driven by a rise in time deposits; the demand deposits to assets ratio is relatively stable. The rise in deposits relative to assets is mirrored by a fall in equity-to-assets and thus a rise in book leverage. Wholesale funding also rises at a similar pace in percentage terms, but from a lower initial share of assets.[14] However, in the two years before failure, deposit funding as a share of total assets starts to decline and is replaced nearly one-for-one by more expensive wholesale funding, likely reducing bank profitability. In the absence of deposit insurance, depositors gradually pull back from failing backs one to two years before failure.

3.3 Boom and Bust

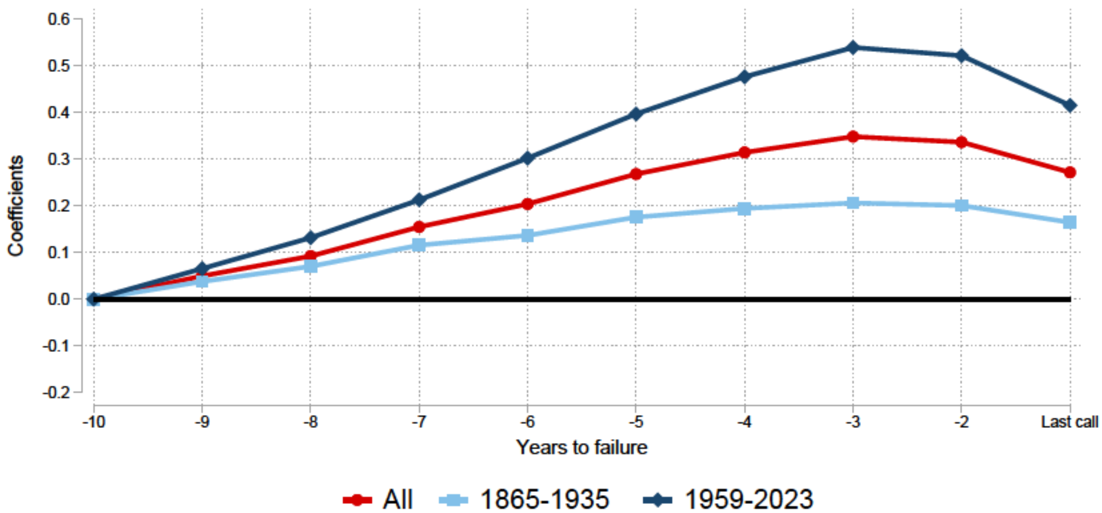
Fact 3. Failing banks follow a boom-bust pattern. They grow rapidly, both in absolute terms and relative to their peers, up to three years before they fail and then contract.

Why do banks experience gradually rising losses that eventually leads to failure? One hypothesis is that rapid loan growth leads banks to overextend themselves and incur future credit losses (Baron and Xiong, 2017; Fahlenbrach et al., 2018; Müller and Verner, 2023; Meiselman et al., 2023). Figure 4 presents results from estimating Equation (1) with

[14] Appendix Figure B.4 presents the dynamics of liabilities in logs, as opposed to as a share of assets.

the log of total assets as the dependent variable. The figure reveals that total assets in failing banks follow a boom-and-bust pattern in the decade before failure. In the full sample, assets expand by over 30% in real terms from ten years to three years before failure and then contract over the last two years before failure. Figure 4 also presents the dynamics of assets in failing banks separately for the pre-FDIC sample and the modern sample. The boom-and-bust pattern is present in both samples. However, it is significantly more pronounced in the modern period.[15]

Figure 4: ***Assets in Failing Banks: 1865-2023***



Notes: This figure reports the sequence of coefficients from estimating Equation (1) with log total assets (deflated by the CPI) as the dependent variable. The regression includes a set of bank fixed effects. The sample is restricted to failing banks and to the ten years before they fail. The sub-samples indicated in the figure legend are selected based on the years in which a bank failed.

There are several potential explanations for why the boom-bust pattern has become stronger in the modern era. First, in the historical period, bank expansions were constrained by geographic restrictions, limiting the growth of individual banks. Second, in recent decades, banks have greater access to more elastic non-core sources of funding, such as brokered deposits and funding in the Eurodollar market.[16] Third, in the historical

[15] Figure B.5 shows the estimates across finer subsamples. Asset growth prior to failure is especially large in the period leading up to the 2008 Global Financial Crisis, followed by the 1959-1981 and 1982-2006 periods.

[16] Accounts of major bank failures in the 1970s and 1980s begin to stress rapid growth financed by non-

period, national banks faced restrictions on lending against real estate, making them less exposed to real estate booms and busts, an important driver of large lending booms. Finally, the anticipation of government interventions and deposit insurance after the Great Depression may have increased risk-taking (Calomiris and Jaremski, 2019).

Which components of assets account for the overall boom in assets? Figure B.6 shows that rapid asset growth is concentrated in illiquid loans. In contrast, liquid assets such as cash and securities rise more slowly than total assets. An implication of the rapid credit expansion in failing banks is that their asset holdings tilt increasingly towards illiquid loans that are associated with higher credit risk in the decade before failure. For the modern sample, we can exploit the additional granularity of the data and decompose the expansion in lending by loan type. Figure B.7 shows that failing banks see the strongest boom in real estate lending (loans secured by real estate), followed by C&I lending. On the other hand, credit card and consumer lending are flat in real terms in the run-up to failure.

The boom-bust pattern is not simply driven by the fact that bank failures are more common at the end of a boom-bust cycle. First, the boom-bust pattern is similar for banks failing outside of major banking crises (see Figure B.8). Second, rapid asset growth predicts subsequent failure in the cross-section of banks (see Figure B.9).[17] In contrast, at short horizons, banks with lowest growth are most likely to fail.

core funding as an important factor. For example, Franklin National Bank of New York and Continental Illinois were both the largest bank failures to date at the time of their failures. These banks both underwent rapid growth financed by wholesale funding, especially from the Eurodollar market (Federal Reserve History, 2023).

[17] The relation between asset growth and future failure is stronger in the 1959-2023 sample. For the historical sample, there is a strong relation between low growth and failure within one to three years, but a weaker relation between rapid growth and failure in five to six years (see Appendix Figure B.10).

4 Predicting Bank Failures with Fundamentals

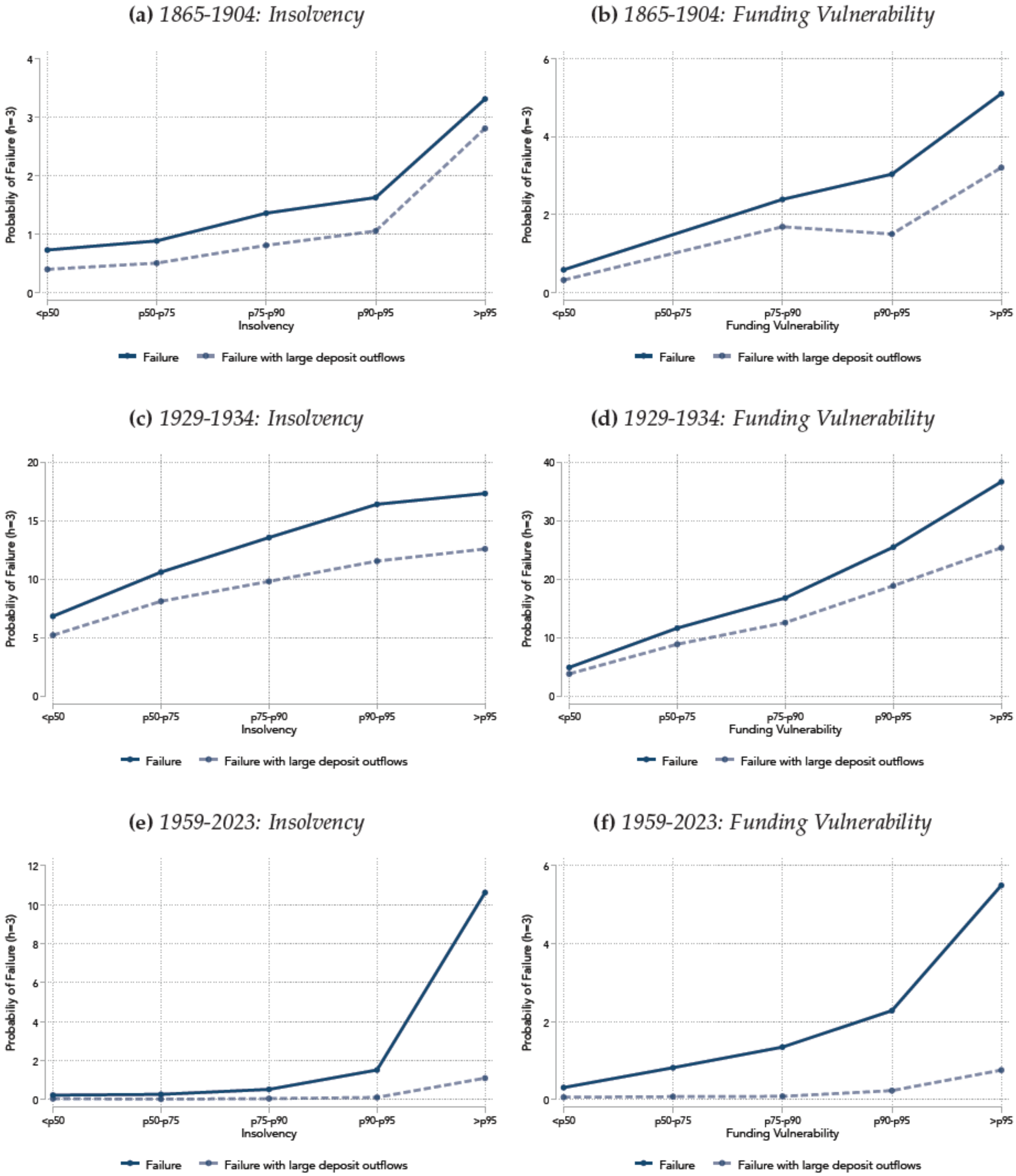
Failing banks follow systematic patterns in terms of solvency, funding, and growth in the decade before failure. The patterns are robust across different institutional settings and extend to the pre-Federal Reserve and pre-FDIC period. In this section, we study the extent to which these systematic patterns allow for the prediction of bank failures. Quantifying the predictability of bank failures based on bank fundamentals is important to establish that the patterns presented in Section 3 are not simply confounded by time trends. Moreover, the degree of predictability of bank failures is also informative about the original causes of failures, as we discuss in more detail below in Section 7.

4.1 Insolvency, Funding Vulnerability, and Failure Rates

Fundamentals and future failures. We first provide a simple visualization of the future probability of failure as a function of bank fundamentals. In Figure 5, we plot the probability of failure over the next three years ($t+1$ to $t+3$) conditional on a bank's fundamentals in year t. We consider two measures of fundamentals. The first measure is a direct proxy for a bank's risk of insolvency. This measure is meant to capture a bank's distance to default. The second measure captures a bank's funding vulnerability. This measure is meant to proxy for both the cost and "flightiness" of the funding structure, such as the reliance on non-core funding. Bank value is often generated through relying on relatively cheap deposit finance (Egan et al., 2021). In contrast, non-core funding such as wholesale deposit or non-deposit wholesale funding are expensive forms of funding and wholesale creditors are typically the most risk-sensitive investors (see, e.g., Perignon et al., 2018; Blickle et al., 2024; Cooperman et al., 2023).

The exact variables we use to measure insolvency or funding vulnerabilities in Figure 5 differ across samples due to differences in data availability. For 1865-1934, we measure insolvency by the reported undivided profits over equity. As discussed in Section 3.1,

Figure 5: *Insolvency, Funding Vulnerability, and Future Probability of Failure*



Notes: This figure plots the probability of bank failure from $t+1$ to $t+3$ against the distribution of proxies for insolvency and funding vulnerability in year t. For the National Banking Era (1865-1904) and Great Depression (1929-1934), insolvency is measured by undivided profits over equity. As discussed in Section 3.1, this measure is a good proxy for bank income and whether bank were restricted by low net income to pay out dividends. Funding vulnerability is measured by wholesale funding over assets. For the Modern Era (1959-2023), solvency is measured by equity-to-assets, and funding vulnerability is measured by time deposits to total deposits. Failures with large deposit outflows are defined as those where deposits fall by more than 7.5% between the last call report and failure. In panels (a) and (b), failures with large deposit outflows are based on the 1880-1904 sample, as the OCC only reports deposits at the time of failure starting in 1880. In panels (e) and (f), failures with large deposit outflows are based on the 1993-2023 sample, as the FDIC only reports deposits at the time of failure starting in 1992.

this measure is a good proxy for bank income and whether banks faced restrictions in paying out dividends due to low net income. For the same period, we measure funding vulnerability by the share of wholesale funding over assets. As discussed above, this type of funding is a form of expensive, non-deposit wholesale funding. For 1959-2023, solvency is measured by equity-to-assets, and funding vulnerability is measured by time deposits to total deposits.

Before proceeding, we emphasize that the measures of insolvency and funding vulnerability are endogenous and interrelated. For example, a bank could have a more vulnerable funding structure because it is experiencing losses. In this case, while funding structure might be the best predictor of failure, the true cause of failure could nevertheless the rising losses. The measures of funding also indirectly affect solvency, as persistent reliance on expensive funding depresses bank profitability. Therefore, we do not interpret the patterns causally. Instead, the insolvency and funding vulnerability measures should both be seen as capturing weak fundamentals that are more likely to be observed in unproductive, and potentially unviable, businesses.

Figure 5 plots the relation between the future probability of failure and measures of insolvency and funding vulnerability for the National Banking Era (1880-1904), Great Depression (1929-1934), and Modern Era (1959-2023). The probability of failure over the next three years is increasing in both exposure to insolvency and funding vulnerability. The relation is generally non-linear, with the risk of failure rising rapidly in the right tails. Moving from below the 50^{th} percentile to above the 95^{th} percentile in the measure of insolvency implies an increase in the probability of failure of 3pp in the National Banking Era, and 10pp in the Great Depression and the modern era. Funding vulnerability is even more predictive of failure in the pre-FDIC data. Moving from below the 50^{th}percentile to above the 95^{th}percentile in funding vulnerability is associated with an increase in the probability of failure of 4.5pp in the National Banking Era, 31pp in the Great Depression, and 5.5pp in the modern era.

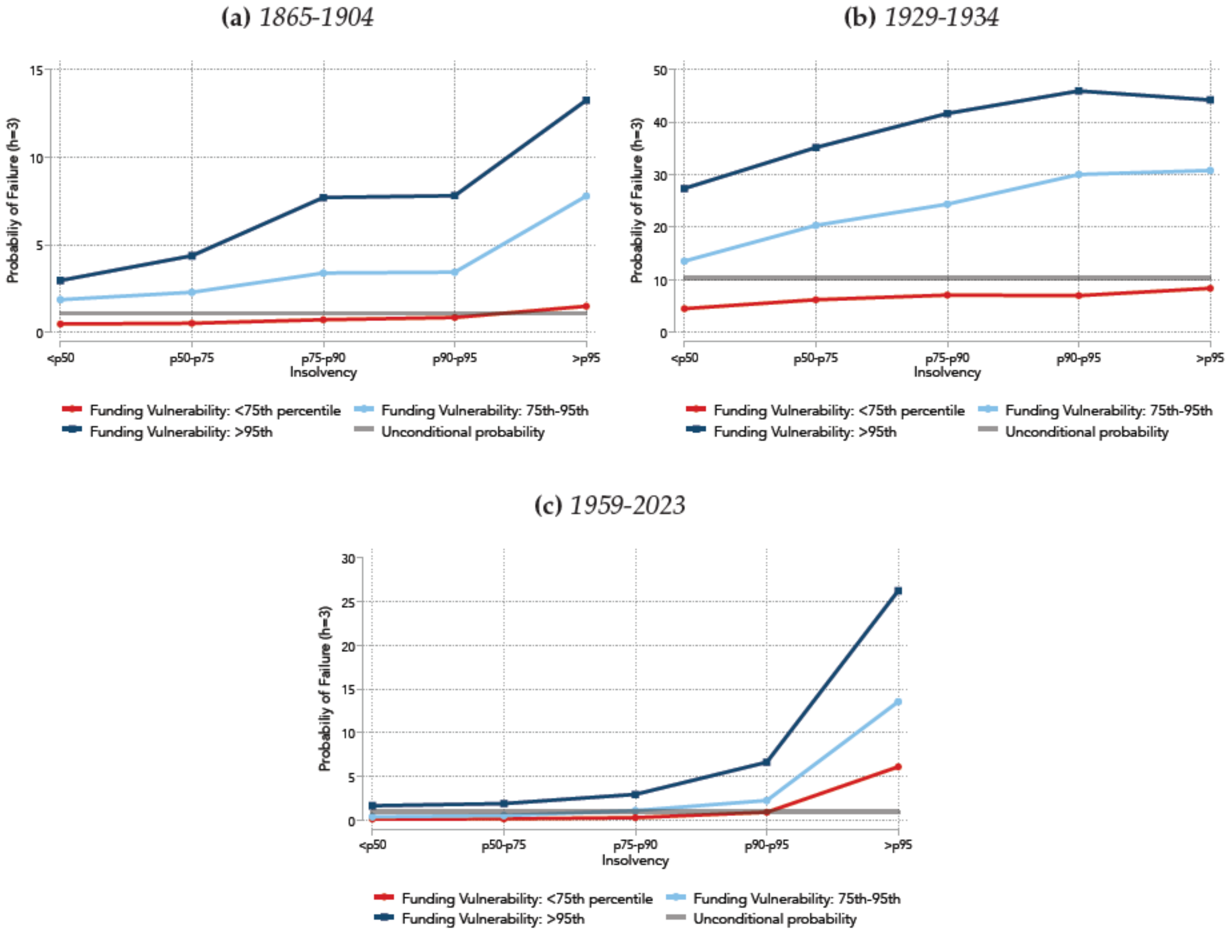
Interaction of insolvency and funding vulnerabilities. Are banks even more likely to fail when they have both weak solvency and are reliant on vulnerable funding? A bank that has weak solvency *and* has costlier and more risk-sensitive financing may see a hastier demise, as creditors raise the cost of financing or withdraw financing more quickly as losses mount (e.g., Jiang et al., 2023). Moreover, as discussed above, funding vulnerability could proxy for exposure to insolvency risk, so the combination of the two measures could provide a stronger signal of a bank at risk of failure.

Figure 6 depicts the probability of bank failure over the next three years ($t+1$ to $t+3$) across the distribution of insolvency by whether funding vulnerability is below the 75$^{\text{th}}$ percentile, between the 75$^{\text{th}}$ and 95$^{\text{th}}$, and above the 95$^{\text{th}}$ percentile. Fundamentals are again measured in year t. The figure confirms that banks with both high insolvency risk *and* high funding vulnerability are the most likely to fail. The probability of failure for a bank that is in the top 5$^{\text{th}}$ percentile of both insolvency and high funding vulnerability is 13% in the National Banking Era, 43% in the Great Depression, and 26% in the modern era. These are large numbers, considering that the unconditional probability of failure over three years is only 0.8% in the National Banking Era, 4.2% in the Great Depression, and 1% in the modern era. Therefore, a bank with both high insolvency risk and high funding vulnerability has a 10-20 times larger probability of failure than a randomly drawn bank. Overall, this illustrates that fundamental measures of insolvency and fragile funding structure strongly predict future failure.

4.2 Performance of Fundamentals in Predicting Bank Failures

Methodology. Fundamentals are strongly associated with the future likelihood of failure. Can failures be predicted with a high degree of accuracy, that is, with a high true positive rate and a low false positive rate? We conduct a formal prediction exercise to quantify the extent to which fundamentals can predict future failures, both in- and out-of-sample.

Figure 6: *Interaction of Insolvency and Funding Vulnerability for Predicting Future Bank Failures*



Notes: This figure plots the probability of bank failure from $t+1$ to $t+3$ against the joint distribution of proxies for insolvency and funding vulnerability in year t. For the National Banking Era (1865-1904) and Great Depression (1929-1935), insolvency is measured by undivided profits over equity, and funding vulnerability is measured by wholesale funding over assets. For the Modern Era (1959-2023), insolvency is measured by equity-to-assets, and funding vulnerability is measured by time deposits to total deposits.

We estimate simple predictive regression models of the following form:

$$\begin{aligned} \text{Failure}_{b,t+1\to t+h} = \alpha &+ \beta_1 \times \text{Insolvency}_{bt} \\ &+ \beta_2 \times \text{FundingVulnerability}_{bt} \\ &+ \beta_3 \times \text{Insolvency}_{bt} \times \text{FundingVulnerability}_{bt} \\ &+ \beta_4 \times \text{Growth}_{bt} \\ &+ \beta_5 \times \text{Aggregate Conditions}_t + \epsilon_{b,t+1\to t+h}, \end{aligned} \tag{2}$$

where $\text{Failure}_{b,t+1\rightarrow t+s}$ is an indicator variable that equals one if bank b fails between year $t+1$ and $t+h$. We include four sets of explanatory variables to predict failure.

First, we include bank-level outcomes that directly or indirectly measure a bank's solvency, denoted Insolvency_{bt}, at time t. These measures include measures of capitalization and exposure to losses. Second, we include bank-level measures of bank funding vulnerabilities, denoted $\text{FundingVulnerability}_{bt}$. We also consider the interaction between the insolvency and funding vulnerability measures. Again, due to differences in data availability, the exact variables we use to capture insolvency and funding vulnerability differ across samples. The exact specifications used for each sample period and the resulting regression coefficients are reported in the Appendix in Table B.6, Table B.7, Table B.8, and Table B.9.

Third, Growth_{bt} is a set of variables that capture bank-specific growth. We use five quintiles of change in log bank assets from year $t-3$ to t. This allows us to capture the non-linear relation between past growth and failure documented in Figure B.9. Fourth, for $\text{Aggregate Conditions}_{t}$, we include aggregate real GDP growth over the same three-year period. These latter two measures are available in the same form throughout the entire 1865-2023 sample. Note that we do not include bank or time fixed effects in the prediction; we only use real-time observables.

To quantify the power of these observables for predicting bank failure, we construct the receiver operating characteristic curve (ROC), a standard tool used to evaluate binary classification ability. The ROC curve traces out the true positive rate against the false positive rate as we vary the classification threshold. We then calculate the area under the ROC curve (AUC). An uninformative predictor has an AUC of 0.5, while an informative predictor has an AUC of greater than 0.5. The AUC metric is commonly used in the literature on predicting financial crises.[18] Furthermore, we test both in-sample

[18] For reference, the in-sample AUC for predicting financial crises in aggregate data based on credit and asset price growth is typically in the range 0.65-0.75 (e.g., Schularick and Taylor, 2012; Drehmann and Juselius, 2014; Baron et al., 2021; Greenwood et al., 2022; Müller and Verner, 2023). Similarly, Iyer et al. (2024) find an AUC of 0.73 when predicting local recessions with bank funding conditions.

and pseudo-out-of-sample classification performance. The pseudo-out-of-sample AUC is constructing by estimating Equation (2) iteratively on an expanding sample and predicting the probability of failure for each bank in $t+1 \rightarrow t+h$ using only data up to year t.

Main results. Table 2 presents the in-sample and out-of-sample AUC statistics based on estimating variants of Equation (2). The table reports the predictive content of various sets of variables for the National Banking Era (1880-1904)[19], Early Fed (1914-1928), Great Depression (1929-1934), and Modern Era (1959-2023). We present results for predicting failure at the 1, 3, and 5 year horizons.

Bank failures are highly predictable based on the AUC metric. The in-sample AUC for the full specification in column (4) ranges from 83% in the National Banking Era to 95% in the Modern Era. On their own, measures of insolvency and funding vulnerability both predict failures. The interaction between solvency and funding adds a significant additional boost to the predictive performance, especially in the National Banking Era, Early Fed Era, and the Great Depression. In the modern sample, where the predictability is extremely high, insolvency alone captures most of the predictive content of fundamentals.

There are several potential reasons for the stronger predictive performance in the Modern Era. First, the quality of the accounting data is higher in the Modern Era. The modern data has information on income statements, and losses are reflected more quickly through explicit accounting for NPLs and loan-loss provisioning. Second, in the historical sample, national banks with unit-branches were less diversified, implying that idiosyncratic shocks accounted for more failures. This makes these failures harder to predict. Third, in the modern sample, bank failures are preceded by larger lending booms, which often imply predictable losses down the road. Finally, the expanded government safety net can delay failure, providing more time for strong signals of failure

[19]Note that we start in 1880 as opposed to 1865 for the following reason: Further below, we also condition on deposit outflows right before failure. However, deposits in failure are only available after 1880. To allow comparability, we thus restrict all specifications to post-1880 data. Results are robust to using the 1865-1904 sample.

to be observed.

The high AUC statistics imply that bank failures can be classified with a high degree of accuracy. Figure B.11, Figure B.12, and Figure B.13 in the Appendix present a visualization of the ROC curve across models for the historical and modern samples. The ROC curve for the Modern Era implies that a forecaster willing to accept a 10% false positive rate can achieve a 85% true positive rate, again illustrating the strong predictability of bank failures.

The pseudo-out-of-sample performance is nearly as strong as the in-sample predictive performance. The high predictability also extends to longer horizons. In columns (6) and (7) we assess the predictability of bank failure over three and five-year horizons. At the five-year horizon, the in-sample AUC is nearly 80% for the historical samples, and it is even higher in the Modern Era.

Additional predictability results. The estimated coefficients for the prediction models reported in Table B.6, Table B.7, Table B.8, and Table B.9 reveal several other interesting results. Bank asset growth is significantly associated with failure. In the short-term, banks with low asset growth have the highest probability of failure. In contrast, at longer horizons of three to five years, the highest probability of failure is for banks that grow *quickly* from $t-3$ to t.[20] In fact, the relative predictive performance of the solvency versus asset growth measures switches when moving from predicting failure in the short-run to the medium run, especially in the modern sample.

Aggregate conditions also matter. Low aggregate GDP growth over the past three years is associated with a higher probability of failure in the National Banking Era and Early Fed Era. This is consistent with Gorton (1988) and Calomiris and Gorton (1991), who find that bank failures and panics in the National Banking Era were more likely following negative macroeconomic news.

[20]This holds for the National Banking Era sample (1865-1904) and the modern sample (1959-2023). However, for the Early Fed and Great Depression samples (1914-1934), banks with the lowest growth are

Table 2: *AUC Metric for Predicting Bank Failures with Fundamentals* .

Prediction horizon h	1 year					3 years	5 years
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: National Banking Era (1880-1904)							
AUC (in-sample)	0.739	0.807	0.827	0.825	0.889	0.767	0.741
AUC (out-of-sample)	0.725	0.801	0.816	0.814	0.866	0.769	0.741
N	73576	73576	73576	73392	73392	73392	73392
No of Banks	5291	5291	5291	5254	5254	5254	5254
Mean of dep. var.	.41	.41	.41	.4	.19	1.1	1.7
Panel B: Early Federal Reserve (1914-1928)							
AUC (in-sample)	0.810	0.787	0.870	0.901	0.898	0.828	0.771
AUC (out-of-sample)	0.828	0.798	0.877	0.892	0.870	0.826	0.790
N	92254	92631	92254	91865	91865	91865	91865
No of Banks	9345	9345	9345	9324	9324	9324	9324
Mean of dep. var.	.64	.63	.64	.64	.34	2.5	5.6
Panel C: Great Depression (1929-1934)							
AUC (in-sample)	0.749	0.770	0.819	0.830	0.827	0.803	0.808
AUC (out-of-sample)	0.644	0.730	0.732	0.720	0.668	0.688	0.720
N	32795	32818	32777	32702	32702	32702	32702
No of Banks	7429	7428	7428	7419	7419	7419	7419
Mean of dep. var.	3.5	3.5	3.5	3.5	2.1	9.8	12
Panel D: Modern Era (1959-2023)							
AUC (in-sample)	0.945	0.808	0.950	0.951	0.936	0.878	0.816
AUC (out-of-sample)	0.931	0.783	0.938	0.938	0.919	0.854	0.787
N	616046	614680	614680	604764	209731	604764	604764
No of Banks	22155	22152	22152	22127	14432	22127	22127
Mean of dep. var.	.26	.26	.26	.27	.035	.88	1.4
Specification details							
Insolvency	✓		✓	✓	✓	✓	✓
Funding vulnerability		✓	✓	✓	✓	✓	✓
Insolvency × Funding vuln.			✓	✓	✓	✓	✓
Growth				✓	✓	✓	✓
Deposit outflow before failure					>7.5%		
Age controls	✓	✓	✓	✓	✓	✓	✓

Notes: This table reports the area under the receiver operating characteristic curve (AUC) across different specifications, samples, and horizons using in-sample and pseudo-out-of-sample classification. The corresponding regression coefficients underlying the models for Panel A can be found in Table B.6, Panel B in Table B.7, Panel C in Table B.8, and Panel D in Table B.9. Pseudo-out-of-sample AUCs are obtained by estimating the regression model with training data from 1880-1890 (Panel A), 1914-1919 (Panel B), 1880-1904 (Panel C), and 1959-1969 (Panel D) and iteratively expanding the sample for subsequent years. Column (5) in Panel D is restricted to the years from 1993-2023 due to unavailability to deposits in failure before 1992.

5 Failures With and Without Bank Runs

Next, we focus on failures featuring bank runs and contrast these to failures without runs. We exploit that our data allows us to calculate deposit outflows immediately before failure, and we define a failure with a run as a failure featuring a large deposit outflow immediately before failure. These data allow us to ask: How large are deposit outflows right before failure? And does the predictability of bank failures differ across failures that do and do not involve runs?

5.1 Deposit Outflows in Failing Banks

Figure 7 visualizes the distribution of deposit growth immediately before failure, and Table 3 reports details on the distribution of deposit growth immediately before failure for the pre and post-FDIC samples (Panel A), as well as by specific eras (Panel B).[21] Large deposit outflows were common before the FDIC became operational but not thereafter. On average, banks experienced a 11.8% decline in deposits immediately before failure prior to the founding of the FDIC, but only a 2.3% decline after the introduction of federal deposit insurance. Deposit outflows in failing banks were highest during the Great Depression. Before the banking holiday, deposits declined by an average of 20.1% between the last call and failure. In contrast, average outflows were much more modest after the introduction of deposit insurance and have been 2% in the most recent years, a sample that includes the 2008 Global Financial Crisis.

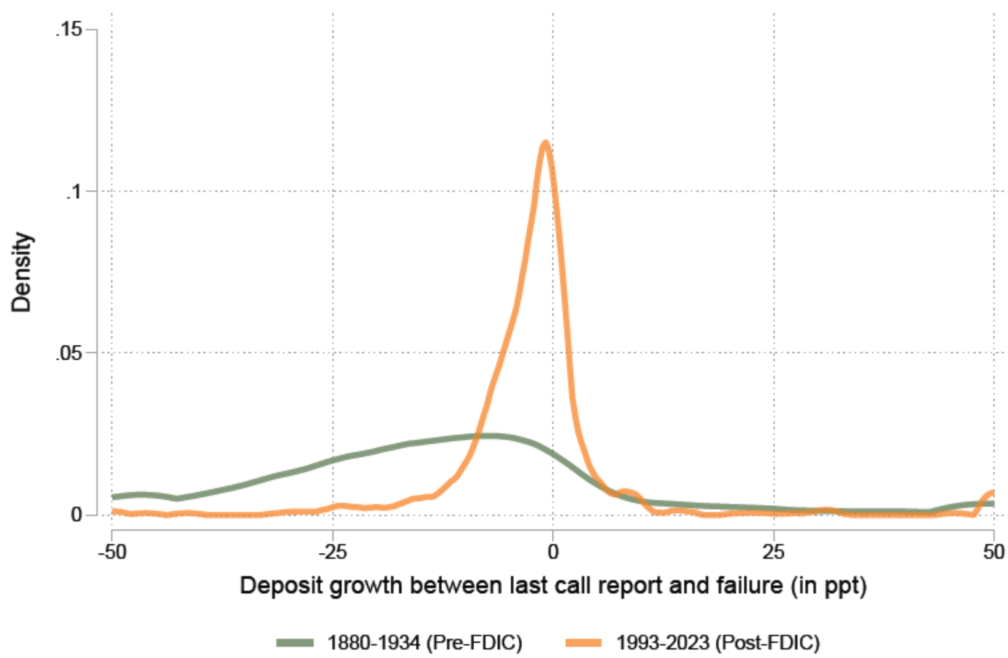
Importantly, in the historical sample, we indeed find evidence that bank failures were commonly associated with bank runs. For instance, 34% of all pre-FDIC failures were preceded by deposit outflows of more than 20%. In contrast, such large outflows are rare

also most likely to fail in five years.

[21] For the historical sample, deposits at the time of failure are the deposits recorded at suspension by the OCC. For the modern sample, deposits at failure are based on deposits at resolution reported in the FDIC Failure Transaction Database. In addition to deposits, Table B.11 shows the growth in assets between the last call report and failure. Note that the assets reported in failure are book values and can include potentially doubtful or worthless assets.

after the end of the Great Depression and only happen in 3% of all failures. However, we also find that, even before deposit insurance and when depositors had reason to expect large losses from a bank default, deposits did not always flow out of failing banks. In one-fourth of all pre-FDIC failures, deposits did not decline by more than 2.5% before failure; in 37% of all failures, deposits fell at most by 7.5%.

Figure 7: ***Deposit Outflow between Immediately before Bank Failure***



Notes: This figure shows the distribution of the growth in deposits between the last call report from before failure and the deposits reported in failure. Deposit growth is clipped at +/- 50ppt. We include failures from 1934 in the pre-FDIC sample. Even though the FDIC was founded in 1933, many receiverships in 1934 were associated with suspensions in 1933, see Appendix A.

5.2 Predictability of Failures with Large Deposit Outflows

In Figure 5, we saw that the conditional probability of failure over the next three years is increasing in measures of insolvency and funding vulnerability. Figure 5 also plots the likelihood of a failure *with a large deposit outflow* across the same bank fundamentals. We define a large deposit outflow occurring if deposits decline by more than 7.5% between the last call report and failure. The cutoff is necessarily arbitrary, but the results are

Table 3: ***Net Deposit In- and Outflows in Failing Banks Before and After the FDIC.***

Era	Average	Share of failures with deposit growth falling within...					
		<-30%	[-30,-20%]	[-20,-7.5%]	[-7.5,-2.5%]	[-2.5,0%]	>0%
Panel A: Pre versus Post-FDIC							
1880-1933 (Pre-FDIC)	-11.81	0.17	0.17	0.29	0.12	0.06	0.19
1993-2023 (Post-FDIC)	-2.26	0.01	0.02	0.12	0.28	0.33	0.29
Panel B: By Era							
1880-1913 (NB Era)	-4.68	0.20	0.13	0.18	0.07	0.03	0.40
1914-1918 (Early Fed)	-9.47	0.15	0.15	0.29	0.11	0.05	0.24
1929-1933 (Depr., pre-Hld.)	-20.12	0.23	0.27	0.33	0.08	0.03	0.06
1933-1934 (Depr., post-Hld.)	-4.88	0.03	0.05	0.31	0.28	0.17	0.16
1993-2006	-3.45	0.03	0.10	0.23	0.13	0.36	0.48
2007-2023	-2.03	0.00	0.00	0.10	0.31	0.33	0.26

Notes: This table reports the percent change in nominal deposits from the last call report before failure to the time of failure. From 1880 through 1934, deposits in failure are as reported in the OCC annual reports table on national banks in receivership. This records deposits "at date of suspension." After 1992, we use deposits in failure as reported in the FDIC's Failure Transaction Database. We further split the Depression sample into failures before and after the banking holiday in March 1933.

robust to different cutoff choices.

Figure 5 reveals that fundamentals strongly predict failures with large deposit outflows. In both the National Banking Era and the Great Depression, moving from healthy fundamentals (below the 50thpercentile) to high insolvency or funding vulnerability is associated with an increase in the probability of failure that is similar to the increase for all failures. While failures with large deposit outflows are rare in the modern sample, these failures are also associated with significantly weaker fundamentals. Thus, the failures associated with large deposit outflows—failures that likely involved runs—are not wholly unexpected events that are disconnected from fundamentals. Instead, they are consistent with depositors reacting to weak bank fundamentals and anticipating failure.

Further, we estimate Equation (2) separately for failures with large deposit outflows. Comparing columns (4), (5), and (6) in Table 2 reveals that the predictive performance of fundamentals is at least as strong for bank failures with large deposit outflows as for failures without large deposit outflows. In the National Banking Era, the in-sample AUC is 83% for all failures and 89% for failures with large deposit outflows. In the Early Fed period, the in-sample AUC is 90% both for failures with large deposit outflows and for all failures. The in-sample AUC for the Great Depression is also very similar for with and without large deposit outflows (83%). Failures with runs are thus as easy, if not easier, to predict than failures without runs. One possible reason is that the latter is more commonly associated with fraud, which is less well detected in financial statements than realized asset losses from bad investments. This finding of high predictability of failures with large deposit outflows cuts against the view that failures before the Federal Reserve or deposit insurance were unpredictable and could occur in banks without weak fundamentals due to non-fundamental runs.

5.3 Additional Evidence: OCC Cause of Failure Classification

So far we have shown that failures with large deposit outflows are predicted by deteriorating fundamentals. This suggests that deposit outflows are a consequence of weak fundamentals, rather than the ultimate cause of failure. At the same time, our empirical approach does not allow us to explicitly identify whether a bank failed because of deposit withdrawals. To reinforce the argument, it is therefore informative to consider contemporary accounts of the causes of failure.

For most national bank failures occurring between 1863 and 1937, the OCC provides the "cause of failure" identified by the bank examiner. We classify the detailed causes of failure by the OCC into seven broad categories: economic conditions, excessive lending, losses, fraud, governance issues, run, and other factors (see Appendix Table C.2 for the exact classification). While the OCC classification may contain errors or biases, it nevertheless provides insight into what examiners on the ground saw as the main cause of failure.

Figure 8 summarizes the distribution of the cause of failure for failures occurring between 1865 and 1937. The most common category is "economic conditions." This category includes failures attributed to deflation, crop loss, or a local financial depression. The second most common category is "losses." The first two categories are thus directly related to economic shocks that deteriorate a bank's asset quality. The third most common category is "fraud." In addition to facilitating risk-taking, fraud is often used to mask losses. Other common causes are "governance issues" and "excessive lending," which refers to a bank with excessive exposure to one counterparty. The most common causes of failure are thus related to deteriorating asset quality and poor fundamentals.

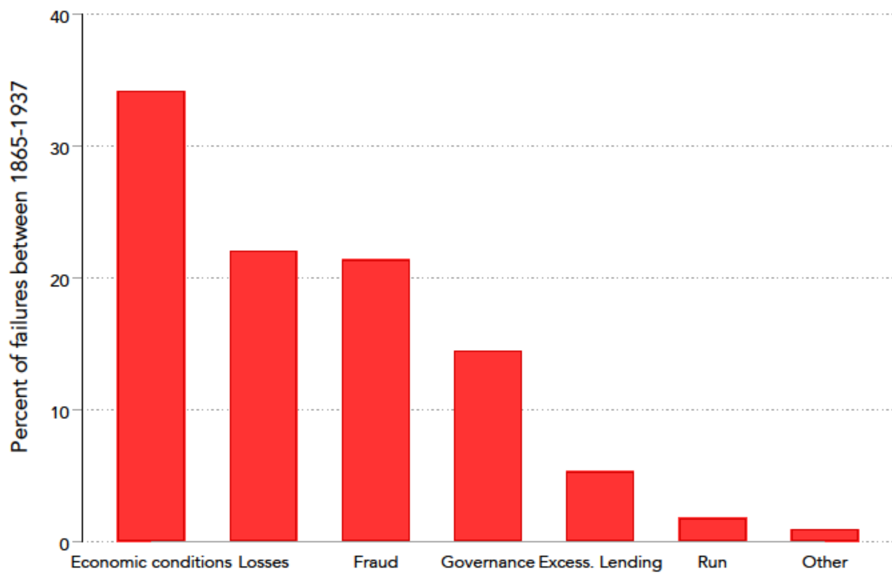
On the other hand, failures caused by runs are much less common, accounting for only a little more than 1% of all failures. "Run" covers instances where the bank was closed by a run, heavy withdrawals, and lack of public confidence. It also covers instances where the bank was closed by directors in anticipation of a run or due to rumors of a run. The limited role for runs in explaining bank failures is also consistent with the low failure rates during most of the banking "panics" of the National Banking Era, since if runs were important for explaining bank failures, one would expect large spikes in failures during "panic" years when banks faced systemic liquidity shocks.[22]

Systematic classification of the cause of bank failures by the OCC is only partial for failures that occurred during 1929-1931 and is not available for banks that failed in 1932 or 1933. Using classifications from the Federal Reserve Board of Governors, Richardson (2007) finds that, for the period 1929 through 1933, the main cause of failure of Federal Reserve member banks was asset losses, but illiquidity from heavy withdrawals also played a contributing role. The evidence from the historical sample is also consistent with a detailed study conducted by the OCC of 171 bank failures between 1979 and 1987 (Graham and Horner, 1988). That study argued that the "major cause of decline for problem banks continues to be poor asset quality that eventually erodes a bank's

[22]Calomiris and Gorton (1991) analyze the same source, but only use data from a subset of years in the pre-1914 sample in which they identified a banking panic. They find that asset losses and fraud were the predominant causes of failure during panic years. Even in banking panic years, the OCC only identified one failure due to a bank run. They concluded that "the fact that the Comptroller only attributed one failure to a bank run per se shows that the *direct* link between bank runs and bank failures during panics was not important" (Calomiris and Gorton, 1991, p. 154).

capital."[23] Poor asset quality was most often caused by poor management decisions and practices, such as imprudent lending practices, excessive loan growth, and fraud.[24]

Figure 8: ***Causes of Failure as Classified by the OCC: 1865-1937***



Notes: Causes of failure are as classified by the OCC in the tables of national banks in charge of receivers from the OCC annual report to Congress for various years. We categorize the detailed list of failure reasons as described in Appendix C.2. The classification of the causes of bank failures by the OCC is essentially complete for failures from 1865-1928, partially complete for failures from 1929-1931 and 1934-1937, and entirely missing for failures in 1932 and 1933 (see Figure C.5).

6 Fundamentals and Aggregate Waves of Bank Failures

Individual bank failures are highly predictable based on past fundamentals. In this section, we ask whether the predictability of bank failures based on fundamentals carries

[23]Graham and Horner (1988) write (also highlighted by Acharya and Naqvi (2012)): "Management-driven weaknesses played a significant role in the decline of 90 percent of the failed and problem banks the OCC evaluated. Many of the difficulties the banks experienced resulted from inadequate loan policies, problem loan identification systems, and systems to ensure compliance with internal policies and banking law. In other cases, directors' or managements' overly aggressive behavior resulted in imprudent lending practices and excessive loan growth that forced the banks to rely on volatile liabilities and to maintain inadequate liquid assets. Insider abuse and fraud were significant factors in the decline of more than one-third of the failed and problem banks the OCC evaluated... Economic decline contributed to the difficulties of many of the failed and problem banks... Rarely, however, were economic factors the sole cause of a bank's decline."

[24]Bennett and Unal (2015) find that fraud was a primary or contributing cause of failure in 24% of failures based on a sample of failures between 1989 and 2007.

over to predicting aggregate waves of bank failures during systemic banking crises.

While fundamentals may predict individual bank failures, the connection between fundamentals and failures during systemic banking crises may differ for two reasons. First, fundamentals could become less predictive of failures during crises in which many banks fail. For example, panics may decouple bank failures from fundamentals. Increased uncertainty during crises may lead creditors to withdraw even from healthy banks, breaking the cross-sectional link between weak fundamentals and failure (Chari and Jagannathan, 1988; Gorton, 1988; Allen and Gale, 1998).[25]

We find no evidence that fundamentals are less predictive of bank failures during crises. In fact, the AUC is generally higher during times of major banking crises (see Table B.10 in the Appendix). Therefore, if anything, fundamentals perform better in ranking which banks are likely to fail during crises compared to during normal times.

Second, crises may feature *excess failures* beyond what is predicted by fundamentals during normal times due to amplification mechanisms. For example, crises can feature chain reactions where bank failures lead to contagion losses for other banks through interdependent claims (Allen and Gale, 2000; Acemoglu et al., 2015) and fire sales that weaken all banks (Gertler and Kiyotaki, 2015). Amplification can also occur through contagion that leads to funding pressure for weak banks. These amplification mechanisms can increase the fundamental threshold at which banks fail, leading more banks to fail than they would otherwise.

We examine whether deteriorating fundamentals can forecast the aggregate rate of bank failures, including spikes in bank failures during systemic banking crises. We perform a pseudo-out-of-sample exercise to predict waves of bank failures as follows. Let t_0 be the first year in the sample. For each year $t > t_0 + t_{training}$, we estimate the predictive model in Equation (2) using only data from t_0 to t. As the baseline,

[25]If some depositors are informed about which banks have worse fundamentals, that will lead lower quality banks to fail. However, if all depositors are equally uninformed, then depositors cannot tell apart healthy from unhealthy banks and even banks with strong fundamentals can fail (Dang et al., 2017).

we use the model in column (4) from Table 2, namely the model with Insolvency_{bt-1}, $\text{FundingVulnerability}_{bt-1}$, their interaction, Growth_{bt}, and Aggregate Conditions_t. With this model estimated on data up until t, we predict the bank-specific failure rate in year $t+1$: $\hat{p}_{b,t+1|t}$. At time t, we thus have the pseudo-out-of-sample predicted probability of failure in $t+1$ for each bank b. We then compute the average predicted failure rate

$$\overline{p}_{t+1|t} = \sum_{b \in B_t} w_{bt} \hat{p}_{b,t+1|t},$$

where w_{bt} is the weight on bank b at time t and B_t is the set of all banks in year t.[26] We set $t_{training} = 10$ years. As in Table 2, we estimate $\overline{p}_{t|t-1}$ separately for the 1865-1904, 1905-1929, 1930-1935, and 1959-2023 samples due to differences in data availability. We weight banks equally. Results are similar when weighting banks by size.

Table 4: ***Fundamentals Predict Aggregate Rate of Bank Failures***

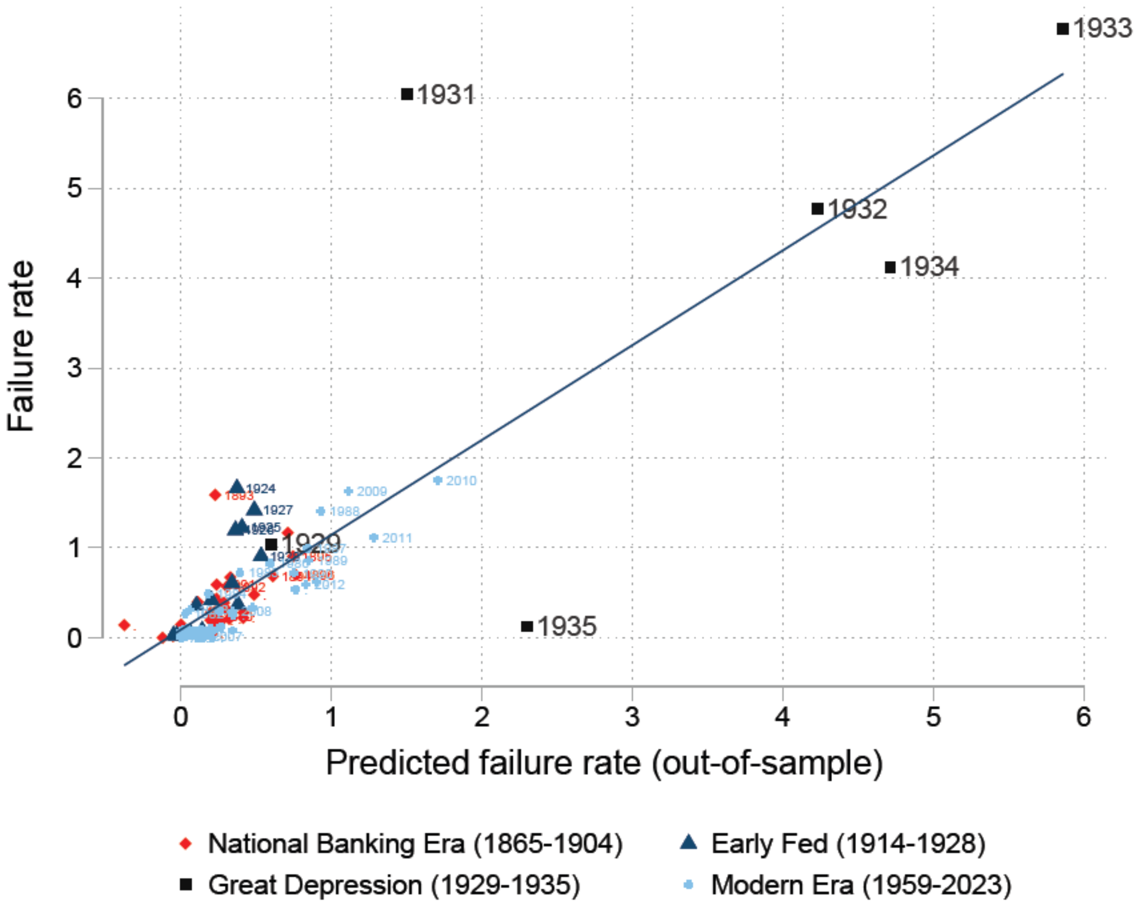
Dependent variable	Aggregate Failure Rate			
	(1)	(2)	(3)	(4)
Predicted failure rate, $\overline{p}_{t\|t-1}$	1.06***	0.79***	0.97***	1.05***
	(0.10)	(0.17)	(0.10)	(0.08)
Constant	0.09**	0.19**	0.52*	-0.03
	(0.04)	(0.08)	(0.27)	(0.02)
N	100	29	18	53
R^2	.72	.3	.66	.85
Sample	Full	1877-1905	1917-1935	1969-2021

Notes: This table presents time series regressions of the annual aggregate failure rate in year t on the average predicted failure rate $\overline{p}_{t|t-1}$. The average predicted failure rate is constructed out-of-sample using an expanding sample that only incorporates information up to year $t-1$. The predicted failure rate is based on the model in column (4) of Table 2. Appendix Table B.12 presents the predictive performance using other models from Table 2. The first observations in columns 2, 3, and 4 are for years 1877, 1917, and 1969, respectively, as we require 10 years of training data to construct the first out-of-sample prediction. Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Figure 9 plots the realized aggregate failure rate against the out-of-sample predicted

[26] In a similar vein of combining information from micro-data with macro forecast variables, Banerjee et al. (2022) find that micro-level data on borrower-level repayment ability helps predict aggregate non-performing loan and bankruptcy rates.

Figure 9: *Fundamentals Predict Aggregate Waves of Bank Failures*



Notes: This figure plots the realized aggregate failure rate against the predicted aggregate failure rate, $\overline{p}_{t|t-1}$. The predicted aggregate failure rate for year t is constructed using only information up to year $t-1$, so the prediction is pseudo out-of-sample. Both measures start 10 years after the start of our data so that we have a sufficiently long training sample. The predictions for each sample period are based on the models in column (4) of Table 2. Figure B.14 in the Appendix shows this figure separately by era. Table 4 reports the regression version of this figure for the full sample and by era.

aggregate failure rate, $\overline{p}_{t|t-1}$. Table 4 presents estimates of the corresponding time-series regression:

$$\text{FailureRate}_t = \alpha + \beta \overline{p}_{t|t-1} + u_t.$$

There is a strong positive relation between the predicted and the realized failure rate. The R^2 for the full sample is 71%. Furthermore, the estimated slope in column (1) of Table 4 is statistically indistinguishable from one, and the constant is not too far from zero. Taken at face value, this implies that crises do not feature excess failures beyond what would be predicted by deteriorating fundamentals.[27] Thus, there is strong out-of-sample predictability of aggregate bank failures based on past fundamentals. Deteriorating fundamentals matter not only for individual bank failures; they are also key to understanding widespread bank failures during the major U.S. banking crises.

Focusing on specific episodes, Figure 9 reveals that fundamentals predict waves of bank failures in the Great Depression and the 2008 Global Financial Crisis. An interesting exception is 1931, when the model substantially underpredicts the rate of failures, suggesting that amplification through contagion or fire sales could have exacerbated the rate of failures in that year. Figure B.14 and Table 4 columns (2)-(4) zoom in on specific eras. The predictability of aggregate waves of failures based on fundamentals also holds for other episodes such as the aftermath of the Panic of 1893, the 1920s, and the Savings and Loan Crisis.

The predictability of aggregate failures is especially high in the modern sample. This is likely partly due to improvements in the accounting data, which more quickly reflect bank losses. However, it may also reflect a change in the nature of bank failures. In the post-FDIC era, the timing of failure is partly determined by government supervisors, since deposit insurance can blunt market forces that would force a bank failure (Walter, 2004). Therefore, in the modern period, bank failures occur later in crises. For example, during the 2008 financial crisis, the highest rate of failures occurred in 2010, followed by 2011 and 2009.[28] In contrast, in the historical sample the timing of failure was determined

[27] We should note the caveat that the finding of a slope of one and constant of zero (indicating no excess failures) is sensitive to the exact predictive model used to construct $\overline{p}_{t|t-1}$. Appendix Table B.12 reports robustness to using different predictive models to construct $\overline{p}_{t|t-1}$. Models with a higher AUC in Table 2 perform better when predicting the aggregate failure rate. The finding of no excess failures (slope of one and constant of zero) is limited to the full model in column (4) which includes bank growth and aggregate GDP growth. This is also generally be best model based on the AUC statistics reported in Table 2. The simpler models in columns 1-3 do suggest some role for excess failures. Nevertheless, the R^2 is high for all models, consistent with the high predictive content of fundamentals.

[28] During the Savings and Loan Crisis of the 1980s, regulatory forbearance significantly delayed failure. Since Prompt Corrective Action was introduced in 1991, a critically undercapitalized bank must be closed or raise new capital within 90 days, accelerating failure for troubled banks.

by market forces, such as a run or bank owners seeking to limit their losses.

7 Relating Empirical Findings to Theories of Bank Failures

Which theories are most consistent with the empirical regularities of bank failures in the U.S. over the past 160 years? Are bank failures more commonly caused by bank runs or by deteriorating fundamentals that lead to insolvency?

We emphasize that our empirical approach does not allow us to definitively identify whether a given bank failure was caused by a bank run. Most importantly, whether a bank subject to a run would have remained solvent absent the run is an unobserved counterfactual. However, we can nonetheless make inferences about the original cause of failure by leveraging testable empirical predictions of theoretical models of bank runs. We use these predictions to assess the number of historical bank failures for which a bank run could be a plausible cause of failure and the number of failures where a bank run can be plausibly rejected as the cause of failure.

Specifically, we exploit the following three testable empirical predictions that are shared by a broad class of bank run models.

- **Predictability:** First, if a bank run is the original cause of a bank failure, the predictability of failure should at best be modest. Purely self-fulfilling panic runs as in Diamond and Dybvig (1983) should not be related to fundamentals but strike randomly (see, e.g., Gorton, 1988; Greenwood et al., 2022). Bank runs on troubled but solvent banks as in the models of Rochet and Vives (2004), Goldstein and Pauzner (2005), and He and Xiong (2012) should also only exhibit limited predictability based on information available to depositors. In these models, rational and attentive depositors run at the early signs of distress to avoid substantial losses when a bank fails. If a bank failure could be easily anticipated based on public data that is available to depositors, then depositors would act on this information and run, thus reducing predictability by triggering failure soon after the first signs of distress. Hence, for runs by attentive depositors to bring down a weak but solvent bank, a bank's predicted probability of failure before failure cannot be too high.

- **Deposit Outflows:** Second, for a bank run to represent the cause of a bank failure, deposits have to actually flow out of the bank before failure. In standard theories of bank runs, deposit outflows erode solvency by forcing banks to either liquidate their otherwise valuable assets or replace deposit funding with more expensive wholesale funding (Diamond and Dybvig, 1983; Allen and Gale, 2000; Goldstein and Pauzner, 2005). Hence, if a bank fails with only a minimal decline in deposits, deposit outflows are unlikely to have induced the bank to engage in actions that reduce solvency, so a bank run is unlikely to be the cause of failure.

- **Asset Losses in Failure:** Third, loss rates on assets held at bank failure cannot be too high when a bank run was the cause of failure (and the bank would have survived absent the run). Unlike non-financial firms, which hold mostly assets that are considerably more valuable inside a firm than outside a firm (see, e.g., Lian and Ma, 2021; Kermani and Ma, 2022), banks largely hold assets that can be separated and repossessed, such as securities and loans. OCC receivership proceedings effectively held assets to maturity to maximize the recovery rates. Hence, recovery rates on assets held in bankruptcy should be relatively high if a bank failure is caused by a bank run on an *ex ante* solvent bank. By and large, the scope of a bank run to destroy value stems from destroying a bank's franchise value, not from reducing the value of assets still held after bank closure.[29] Ma and Scheinkman (2020) estimate that the going-concern value of bank assets is only around 10-15% of assets, which

[29] The scope of bank runs to reduce the value of assets held at failure is limited, as the bank failure itself would have to substantially increase the probability of default by bank borrowers. Importantly, a bank run is unlikely to make these loans entirely worthless. As discussed in Section 3.1, the share of assets assessed as "worthless" by examiners right after a bank closed its doors correlates highly with subsequent realized losses. Thus, the majority of unrealized asset losses stem from past investment decisions for which losses seem to have been baked in before failure.

is much smaller than the going-concern value of non-financial firms (Lian and Ma, 2021). Similarly, Hirtle and Plosser (2024) estimate that the value of a bank's deposit franchise—which can be destroyed in a run (see, e.g., Drechsler et al., 2023)—is typically between 5-10% of the book value of assets. Thus, the value of a bank absent failure, while unobservable, can be approximated by the recovery value of the assets held and the going-concern value of a bank. Given that the run primarily destroys the latter, for a bank run to be a plausible cause of failure, the recovery rate on assets cannot be too low. If recovery rates are high, it would be plausible that the run destroyed the bank's franchise value, but the bank would have been solvent absent the run. In contrast, very low recovery rates would indicate that a bank was insolvent irrespective of whether a run took place or not.

In Table 5, we report the joint distribution of failures in the pre-FDIC era by predictability, deposit outflows, and asset recovery rates. We define a failure as having high predictability if the out-of-sample predicted probability of failure over the next three years right before failure is above 7.5%, modest predictability if the probability of failure is between 2.5% and 7.5%, and unpredictable if the predicted probability of failure is less than 2.5%.[30] Note that we use the out-of-sample predicted probability of failure and thus information that is in principle also available to contemporary depositors.

Further, we group banks into those that have deposit inflows before failure, modest deposit outflows of up to 7.5%, and large deposit outflows of more than 7.5% before failure.

Finally, we define a bank as having low asset losses if the recovery value of its total assets exceeds 75% throughout the receivership process, moderate losses if the recovery rate is between 50-75%, and high losses if the recovery rate is below 50%. Note that equating a recovery of 75% with having low losses is rather conservative, given that these are still considerable losses. If we assume that a bank's franchise value is somewhere

[30]Note that the cutoffs we present here are necessarily arbitrary. We report the more detailed joint distribution in Figure B.15 in the Appendix.

between 5-20%, then a bank would already be insolvent absent a run when recovery rates fall short of 80%. Table 5 presents the joint distribution for pre-FDIC failures where each of these three variable is non-missing.

Purely liquidity-driven, self-fulfilling bank runs Consider first the potential of purely self-fulfilling bank runs (e.g., Diamond and Dybvig, 1983; Peck and Shell, 2003) or shocks to the demand for liquidity (e.g., Allen and Gale, 2000) to represent a common cause of bank failures or banking crises. These types of failures should exhibit high deposit outflows, low predictability, and low asset losses in default.

Unsurprisingly, Table 3 above shows that bank runs preceding failure are not common in the modern, post-1959 sample. We find that deposit outflows before failure are modest in the Modern Era. Deposit insurance provided by the FDIC insulates a large share of depositors from a bank's solvency risk. Moreover, uninsured deposits also have low expected loss rates in the Modern Era, as shown in Table B.4. These facts have made bank runs very rare.

However, the facts presented in Table 5 also reject the notion that self-fulfilling runs on solvent banks were a common cause of bank failures even before federal deposit insurance was instituted. We find that bank failures featuring low predictability, large deposit outflows, and low losses are extremely rare. In particular, we find that only 5 failed banks (0.3% of failures) had an out-of-sample predicted failure probability over a three-year horizon of less than 2.5%, deposit outflows right before failure of more than 7.5%, and recovery rates in default of above 75%. This fact suggests that Diamond-Dybvig-style bank runs do not qualify as a plausible explanation of bank failure for the vast majority of failures in the pre-FDIC era.

Table 5: ***Number of Pre-FDIC Failures by Predictability, Deposit Outflows, and Asset Recovery Rate***

Deposit flows before failure (%)	<-7.5			[-7.5,0]			>0			Total
Asset recovery rate at failure (%)	>75	[50,75]	<50	>75	[50,75]	<50	>75	[50,75]	<50	
Predicted Pr[Fail] before failure (%)										
< 2.5	5	46	55	2	9	16	5	26	31	195
	(0.3)	(2.9)	(3.4)	(0.1)	(0.6)	(1.0)	(0.3)	(1.6)	(1.9)	(12.2)
∈ [2.5,7.5]	6	144	181	1	30	42	3	28	51	486
	(0.4)	(9.0)	(11.3)	(0.1)	(1.9)	(2.6)	(0.2)	(1.8)	(3.2)	(30.4)
∈ [7.5,20]	7	211	176	11	52	26	6	29	38	556
	(0.4)	(13.2)	(11.0)	(0.7)	(3.3)	(1.6)	(0.4)	(1.8)	(2.4)	(34.8)
>20	9	114	57	11	94	31	5	24	16	361
	(0.6)	(7.1)	(3.6)	(0.7)	(5.9)	(1.9)	(0.3)	(1.5)	(1.0)	(22.6)
Total	27	515	469	25	185	115	19	107	136	1598
	(1.7)	(32.2)	(29.3)	(1.6)	(11.6)	(7.2)	(1.2)	(6.7)	(8.5)	(100.0)

Notes: This table reports both the number and percentage (in parentheses) of bank failure by predictability, deposit outflows, and asset recovery rate. Predictability is measured as the out-of-sample predicted probability of failure over a three year horizon as of the last call report before failure. Out-of-sample predictions are taken from estimating Equation (2). The out-of-sample predicted probability of failure is obtained from the regression models reported in columns (4) of Table B.6 (1880-1904, using 1870-1880 as training data and iteratively expanding the sample for subsequent years), Table B.7 (1920-1928, using 1915-1919 as training data), Table B.8 (1929-1934, using 1870-1904 as training data). Deposit outflows are calculated as the difference between the deposits reported in the last call report and the deposits reported at failure normalized by the deposits reported in the last call report. Recovery rates are the total funds collected from assets throughout the receivership proceedings divided by the total assets held at bank failure.

Runs on troubled but solvent banks What does our evidence say about the potential for runs on solvent but troubled banks to be a common cause of bank failures?

In Section 5, we found that failures with large outflows are as easy, if not easier, to predict as those without. This fact supports the notion that runs only happen when a bank is sufficiently weak, as is suggested by theories of runs on troubled but solvent banks (see, e.g., Goldstein and Pauzner, 2005; He and Xiong, 2012). Our paper hence generalizes insights from existing empirical studies that have focused on studying specific episodes (see, e.g., Wicker, 1996; Calomiris and Mason, 1997, 2003; Iyer and Puri, 2012) and establishes that weak fundamentals are a necessary condition for a bank to fail, even the in the absence of a safety net and both conditional and unconditional on being in a financial crisis.

However, we also find that the scope for bank runs to cause the failure of troubled but solvent banks is surprisingly limited. Runs on solvent but troubled banks as in the model by Goldstein and Pauzner (2005) should exhibit low to moderate predictability, feature deposit outflows, and exhibit moderate losses in failure. However, we find that only 15% of all failures between 1880 and 1934 fulfill these criteria. In particular, Table 5 shows that only around 15% of all pre-FDIC failures featured low to modest predictability (out-of-sample predicted probability of failure of less than 7.5% over the next three years), deposit outflows, and low to moderate asset losses (a recovery rate of more than 50 cents on the dollar in receivership).

Insolvency-driven bank failures Table 5 shows that more than 80% of pre-FDIC failures were associated with a high likelihood of failure before failure (above 7.5% out-of-sample predicted chance of failure over three years), no deposit outflows, or recovery rates in receivership of less than 50%. Hence, in most bank failures, depositors either did not run at all, even when it may have been wise to do so, or they withdrew their funds from banks that were most likely already deeply insolvent. These patterns suggest that most bank failures are the result of a deterioration of a bank's solvency. Bank runs, to the extent they happen, are more commonly a consequence of imminent failure as opposed to its cause. This is not to say that the run does not matter. The bank run may determine the timing of when an insolvent bank suspends operations and the economic costs of the failure (Diamond and Rajan, 2001).

Our interpretation that insolvency, rather than runs, accounts for the preponderance of failures in the pre-FDIC era is in line with assessments of contemporary bank examiners. As we establish in Section 5.3, examiners commonly cited losses, economic shocks, or fraud, but rarely cited bank runs, as the original cause of failure.

Depositor inattentiveness before deposit insurance Table 5 further reveals that more than 57% of pre-FDIC failures have a predicted probability of failure over the next three years in excess of 7.5% in the year before failure. Further, more than a stunning 23% of all failures are associated with a predicted probability of failure exceeding 20%, which is a very high likelihood of failure for an individual bank.

As noted above, the information we use to estimate the probability of failure is public and is thus available to contemporary depositors. A bank with such a high observed probability of failure is unlikely to be viable if all depositors required fair compensation for being exposed to such a high risk of their bank failing, especially given that we find that depositor loss rates averaged 35% (see Table B.4). Figure B.16 in the appendix presents a simple calculation of the required excess return that both a risk-neutral and a risk-averse depositor would require to be compensated for such a high default risk. It shows that an annual excess rate or return above 5% would have not been uncommon for these high-risk banks. If a bank were actually forced to pay such a high deposit rate, it would arguably become unviable, as interest expenses would erode its solvency. Moreover, the high interest rate itself could be taken by depositors as a signal that the bank is in trouble. However, by construction, these banks have not failed yet. Hence, the fact that these banks have not yet failed and we as econometricians can observe such high predicted failure probabilities implies that depositors appear slow to react to the increased risk of bank failure. Bank runs, to the extent they happen, often seem to happen later than theoretical benchmarks would suggest. This finding, in turn, points to a role for behavioral frictions such as inattentive depositors or neglect of downside risk (e.g., Gennaioli et al., 2012; Jiang et al., 2023).

Theories of banking crises based on asymmetric information Our results also speak to influential theories of banking crises based on asymmetric information (see, e.g., Gorton, 1988; Chari and Jagannathan, 1988; Dang et al., 2017). Under this view, banking crises happen when depositors revise their assessment of banks' risk of failure after receiving signals about the state of the banking system or the economy. These revisions, in turn, can induce system-wide runs by uninformed creditors that cause even healthy banks to fail. Our evidence that bank failures are preceded by losses and economic downturns is consistent with the prediction of asymmetric information models that failures follow bad news. However, our findings also pose challenges to these models. In particular, we find that weak banks that end up failing can be identified quite easily among their peers using publicly available financial statements, even years before their ultimate demise and even in crises. Moreover, banking crises are substantially predictable based on weak fundamentals.

8 Conclusion

This paper studies failing banks using data on more than 37,000 banks from the United States spanning 1865-2023. Taken together, our findings suggest that most bank failures are the result of a deterioration of a bank's solvency. We find that the deterioration of solvency is typically gradual and takes place over several years. During those years, the realization of credit risk reduces income and erodes capital buffers, pushing banks slowly toward the brink of default. At times, the deterioration of a bank's solvency is preceded by a boom-phase during which failing banks likely take more risks at the margin than their peers. The erosion of a bank's profitability and capitalization ultimately results either in a bank run or a supervisory decision to close the bank, with the former being more common in the historical data. Importantly, both depositors and supervisors seem to be slow to react to information about bank fundamentals, thus making bank failures highly predictable.

We emphasize that our empirical approach does not allow us to identify the exact cause of failure. However, our evidence allows us to reject bank runs as a plausible cause of bank failure for a robust majority of at least 80% of pre-FDIC failures. Hence, our evidence suggests that bank runs on otherwise solvent banks are not a plausible common cause of bank failures for most bank failures in the history of the U.S., including the majority of pre-FDIC bank failures.

We further note that our empirical analysis focuses on bank failures, and we do not study bank runs that do not ultimately result in bank failure. Panic-based runs could, in principle, force otherwise healthy banks or banking systems to suspend convertibility of deposits into cash. Such suspensions may have helped avert failure due to cooperation through, for example, bank clearinghouses. Nonetheless, such suspensions can have adverse real economic effects, even if no bank failures follow.

Our findings have several important implications. First, a large theoretical literature explores the role of panic-based runs in increasing financial fragility. There is comparatively less work on understanding why banks experience predictable fundamental deterioration in asset values that erodes their solvency (see, e.g. Chang et al., 2024). What are the frictions that drive decisions that ultimately lead to a deterioration of bank fundamentals? Our evidence suggests that the deterioration of fundamentals is often linked to high growth in the past.

Second, the predictability of bank failures implies a role for *ex ante* interventions to prevent bank failures or mitigate their damage (Gennaioli and Shleifer, 2018). The fact that bank failures are predictable supports the active use of prompt corrective action measures, such as limiting dividend payouts and the use of non-core funding for poorly capitalized banks. More generally, our findings emphasize the importance of requiring financial intermediaries to be well-capitalized. Our findings also imply that *ex post* interventions during a crisis must address fundamental solvency issues. Policies that backstop liquidity without addressing insolvency are unlikely to be sufficient for mitigating the costs of bank failures, as recently argued by Baron et al. (2024).

Finally, our evidence on failures both before and after deposit insurance offers insights for ongoing discussions of deposit insurance reform. Before deposit insurance, failures involving large deposit outflows were common. This suggests that depositor behavior could have been important for determining the exact timing of failure. In contrast, in the modern era, deposit outflows are small, and insured deposits even flow into failing banks. This suggests important changes in the extent to which depositors discipline banks due to changes in regulation, as also suggested by Martin et al. (2023). At the same time, the high predictability of failures in the era before deposit insurance suggests that depositor discipline was, at best, imperfect. More broadly, lending booms preceding failure have increased over time, potentially consistent with increased risk-taking. While such comparisons across eras can only be suggestive, they do highlight both costs and benefits of the expansion in the government safety net.

References

Acemoglu, D., A. Ozdaglar, and A. Tahbaz-Salehi (2015). Systemic risk and stability in financial networks. *American Economic Review 105*(2), 564–608.

Acharya, V. and H. Naqvi (2012). The seeds of a crisis: A theory of bank liquidity and risk taking over the business cycle. *Journal of Financial Economics 106*(2), 349–366.

Admati, A. and M. Hellwig (2014). *The bankers' new clothes: What's wrong with banking and what to do about it*. Princeton University Press.

Allen, F. and D. Gale (1998). Optimal financial crises. *Journal of Finance 53*(4), 1245–1284.

Allen, F. and D. Gale (2000). Financial contagion. *Journal of Political Economy 108*(1), 1–33.

Alston, L. J., W. A. Grove, and D. C. Wheelock (1994). Why do banks fail? evidence from the 1920s. *Explorations in Economic History 31*(4), 409–431.

Artavanis, N., D. Paravisini, C. Robles Garcia, A. Seru, and M. Tsoutsoura (2022). One size doesn't fit all: Heterogeneous depositor compensation during periods of uncertainty. Working Paper 30369, National Bureau of Economic Research.

Banerjee, R., F. Franceschi, and S. Riederer (2022). Borrower vulnerabilities, their distribution and credit losses. *BIS Quarterly Review* (19).

Baron, M., L. Laeven, J. Pénasse, and Y. Usenko (2024). Permanent capital losses after banking crises. *Available at SSRN 3762043*.

Baron, M., M. Schularick, and K. Zimmermann (2023). Survival of the biggest: Large banks and financial crises. *Available at SSRN 4189014*.

Baron, M., E. Verner, and W. Xiong (2021). Banking crises without panics. *The Quarterly Journal of Economics 136*(1), 51–113.

Baron, M. and W. Xiong (2017). Credit expansion and neglected crash risk. *The Quarterly Journal of Economics 132*(2), 713–764.

Bennett, R. L. and H. Unal (2015). Understanding the components of bank failure resolution costs. *Financial Markets, Institutions & Instruments 24*(5), 349–389.

Berger, A. N. and C. H. Bouwman (2013). How does capital affect bank performance during financial crises? *Journal of financial economics 109*(1), 146–176.

Bernanke, B. (2018). The real effects of disrupted credit: Evidence from the global financial crisis. *Brookings Papers on Economic Activity 49*(2 (Fall)), 251–342.

Bernanke, B. S. (1983). Nonmonetary effects of the financial crisis in the propagation of the great depression. *The American Economic Review 73*(3), 257–276.

Blickle, K., M. Brunnermeier, and S. Luck (2024, 05). Who Can Tell Which Banks Will Fail? *The Review of Financial Studies 37*(9), 2685–2731.

Borio, C. E. and P. W. Lowe (2002). Asset prices, financial and monetary stability: exploring the nexus.

Calomiris, C. W. and M. Carlson (2022). Bank examiners' information and expertise and their role in monitoring and disciplining banks before and during the panic of 1893. *Journal of Money, Credit and Banking 54*(2-3), 381–423.

Calomiris, C. W. and G. Gorton (1991). The origins of banking panics: models, facts, and bank regulation. In *Financial markets and financial crises*, pp. 109–174. University of Chicago Press.

Calomiris, C. W. and M. Jaremski (2019). Stealing deposits: Deposit insurance, risk-taking, and the removal of market discipline in early 20th-century banks. *The Journal of Finance 74*(2), 711–754.

Calomiris, C. W. and J. R. Mason (1997). Contagion and bank failures during the great depression: The june 1932 chicago banking panic. *American Economic Review 87*(5), 863–883.

Calomiris, C. W. and J. R. Mason (2003). Fundamentals, panics, and bank distress during the depression. *American Economic Review 93*(5), 1615–1647.

Carlson, M., S. Correia, and S. Luck (2022). The effects of banking competition on growth and financial stability: Evidence from the national banking era. *Journal of Political Economy 130*(2), 462–520.

Chang, B., I.-H. Cheng, and H. G. Hong (2024). The fundamental role of uninsured depositors in the regional banking crisis. *Working paper*.

Chari, V. V. and R. Jagannathan (1988). Banking panics, information, and rational expectations equilibrium. *Journal of Finance 43*(3), 749–761.

Cooperman, H. R., D. Duffie, S. Luck, Z. Z. Wang, and Y. Yang (2023). Bank funding risk, reference rates, and credit supply. Working Paper 30907, National Bureau of Economic Research.

Correia, S. and S. Luck (2023). Digitizing historical balance sheet data: A practitioner's guide. *Explorations in Economic History 87*, 101475.

Dang, T. V., G. Gorton, and B. Holmström (2017). Ignorance, debt and financial crises. *Yale University and Massachusetts Institute of technology, working paper 17*.

Diamond, D. W. and P. H. Dybvig (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy 91*(3), 401–419.

Diamond, D. W. and R. G. Rajan (2001). Liquidity risk, liquidity creation, and financial fragility: A theory of banking. *Journal of Political Economy 109*(2), 287–327.

Drechsler, I., A. Savov, and P. Schnabl (2017). The Deposits Channel of Monetary Policy. *The Quarterly Journal of Economics 132*(4), 1819–1876.

Drechsler, I., A. Savov, and P. Schnabl (2021). Banking on deposits: Maturity transformation without interest rate risk. *The Journal of Finance 76*(3), 1091–1143.

Drechsler, I., A. Savov, P. Schnabl, and O. Wang (2023, April). Banking on uninsured deposits. Working Paper 31138, National Bureau of Economic Research.

Drehmann, M. and M. Juselius (2014). Evaluating early warning indicators of banking crises: Satisfying policy requirements. *International Journal of Forecasting 30*(3), 759–780.

Egan, M., S. Lewellen, and A. Sunderam (2021). The Cross-Section of Bank Value. *The Review of Financial Studies 35*(5), 2101–2143.

Fahlenbrach, R., R. Prilmeier, and R. M. Stulz (2018). Why does fast loan growth predict poor performance for banks? *The Review of Financial Studies 31*(3), 1014–1063.

FDIC (2011). Study on core deposits and brokered deposits. In *Submitted to Congress pursuant to the Dodd-Frank Wall Street Reform and Consumer Protection Act, Juny 8th*.

FDIC (2023). Options for deposit insurance reform. https://www.fdic.gov/analysis/options-deposit-insurance-reforms/index.html.

Federal Reserve History (2023). Continental illinois: A bank that was too big to fail.

Flood, M. D. (1998). United states historical data on bank market structure, 1896-1955. *ICPSR - Interuniversity Consortium for Political and Social Research https://doi.org/10.3886/ICPSR02393.v1*.

Friedman, M. and A. J. Schwartz (1963). *A monetary history of the United States, 1867-1960*, Volume 9. Princeton University Press.

Frydman, C., E. Hilt, and L. Y. Zhou (2015). Economic effects of runs on early "shadow banks": Trust companies and the impact of the panic of 1907. *Journal of Political Economy 123*(4), 902–940.

Gennaioli, N. and A. Shleifer (2018). *A Crisis of Beliefs: Investor Psychology and Financial Fragility*. Princeton University Press.

Gennaioli, N., A. Shleifer, and R. Vishny (2012). Neglected risks, financial innovation, and financial fragility. *Journal of Financial Economics 104*(3), 452–468.

Gertler, M. and N. Kiyotaki (2015). Banking, liquidity, and bank runs in an infinite horizon economy. *American Economic Review 105*(7), 2011–43.

Gilbert, R. A. (1986). Requiem for Regulation Q: what it did and why it passed away. *Review* (Feb), 22–37.

Goldstein, I. and A. Pauzner (2005). Demand–deposit contracts and the probability of bank runs. *Journal of Finance 60*(3), 1293–1327.

Gorton, G. (1988). Banking panics and business cycles. *Oxford Economic Papers 40*(4), 751–781.

Gorton, G. and A. Metrick (2012). Securitized banking and the run on repo. *Journal of Financial Economics 104*(3), 425 – 451. Market Institutions, Financial Market Risks and Financial Crisis.

Gorton, G. B. (2012). *Misunderstanding Financial Crises: Why We Don't See Them Coming*. Number 9780199922901 in OUP Catalogue. Oxford University Press.

Graham, F. C. and J. E. Horner (1988). Bank failure: an evaluation of the factors contributing to the failure of national banks. Proceedings 210, Federal Reserve Bank of Chicago.

Granja, J., G. Matvos, and A. Seru (2017). Selling failed banks. *The Journal of Finance 72*(4), 1723–1784.

Greenwood, R., S. G. Hanson, A. Shleifer, and J. A. Sørensen (2022). Predictable financial crises. *The Journal of Finance 77*(2), 863–921.

Grossman, R. S. (2001). Double liability and bank risk taking. *Journal of Money, Credit and Banking 33*(2), 143–159.

Grossman, R. S. (2010). *Unsettled account: The evolution of banking in the industrialized world since 1800*. Princeton University Press.

Hahm, J.-H., H. S. Shin, and K. Shin (2013). Noncore bank liabilities and financial vulnerability. *Journal of Money, Credit and Banking 45*(s1), 3–36.

Haubrich, J. G. (2020). A Brief History of Bank Capital Requirements in the United States. *Economic Commentary 2020*(05), 1–6.

He, Z. and W. Xiong (2012). Dynamic Debt Runs. *Review of Financial Studies 25*(6), 1799–1843.

Hirtle, B. and M. Plosser (2024). A measure of bank value. *Working paper*.

Huntoon, P. (2023, July). Key bank data, 1863-1935, charters 1-14348: Society of Paper Money Collectors, National Bank & National Bank Note Summary Data.

Iyer, R., S. Kundu, and N. Paltalidis (2024). Canary in the coal mine: Bank liquidity shortages and local economic activity. *Working paper*.

Iyer, R. and M. Puri (2012). Understanding bank runs: The importance of depositor-bank relationships and networks. *American Economic Review 102*(4), 1414–45.

Iyer, R., M. Puri, and N. Ryan (2016). A tale of two runs: Depositor responses to bank solvency risk. *Journal of Finance 71*(6), 2687–2726.

Jalil, A. J. (2015). A new history of banking panics in the united states, 1825–1929: construction and implications. *American Economic Journal: Macroeconomics 7*(3), 295–330.

James, C. (1991). The losses realized in bank failures. *The Journal of Finance 46*(4), 1223–1242.

Jiang, E. X., G. Matvos, T. Piskorski, and A. Seru (2023). Monetary tightening and us bank fragility in 2023: Mark-to-market losses and uninsured depositor runs? Technical report, National Bureau of Economic Research.

Jordà, O., B. Richter, M. Schularick, and A. M. Taylor (2020, 08). Bank Capital Redux: Solvency, Liquidity, and Crisis. *The Review of Economic Studies 88*(1), 260–286.

Jordà, O., M. Schularick, and A. M. Taylor (2017). Macrofinancial history and the new business cycle facts. *NBER Macroeconomics Annual 31*, 213–263.

Kermani, A. and Y. Ma (2022). Asset Specificity of Nonfinancial Firms. *The Quarterly Journal of Economics 138*(1), 205–264.

Krishnamurthy, A., S. Nagel, and D. Orlov (2014). Sizing up repo. *Journal of Finance 69*(6), 2381–2417.

Kroszner, R. S. and P. E. Strahan (2014). Regulation and deregulation of the us banking industry: causes, consequences, and implications for the future. In *Economic regulation and its reform: what have we learned?*, pp. 485–543. University of Chicago Press.

Lian, C. and Y. Ma (2021). Anatomy of corporate borrowing constraints. *The Quarterly Journal of Economics 136*(1), 229–291.

Ma, Y. and J. A. Scheinkman (2020). Going-concern debt of financial intermediaries. Working Paper 28088, National Bureau of Economic Research.

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 (2023, August). Judging banks' risk by the profits they report. Working Paper 31635, National Bureau of Economic Research.

Metrick, A. and P. Schmelzing (2021). Banking-crisis interventions, 1257-2019. Technical report, National Bureau of Economic Research.

Mitchener, K. J. and G. Richardson (2019). Network contagion and interbank amplification during the great depression. *Journal of Political Economy 127*(2), 465–507.

Müller, K. and E. Verner (2023). Credit allocation and macroeconomic fluctuations. *Available at SSRN 3781981*.

Office of the Comptroller of the Currency (1941). *Alphabetical List of National Banks by States*. U.S. Government Printing Office.

Peck, J. and K. Shell (2003). Equilibrium bank runs. *Journal of Political Economy 111*(1), 103–123.

Perignon, C., D. Thesmar, and G. Vuillemey (2018). Wholesale funding dry-ups. *Journal of Finance 73*(2), 575–617.

Rajan, R. G. and R. Ramcharan (2016). Constituencies and legislation: The fight over the mcfadden act of 1927. *Management Science 62*(7), 1843–1859.

Reinhart, C. M. and K. S. Rogoff (2009). The aftermath of financial crises. *American Economic Review 99*(2), 466–472.

Richardson, G. (2007). Categories and causes of bank distress during the great depression, 1929-1933: The illiquidity versus insolvency debate revisited. *Explorations in Economic History 44*(4), 588–607.

Richardson, G. and W. Troost (2009). Monetary intervention mitigated banking panics during the great depression: Quasi-experimental evidence from a federal reserve district border, 1929–1933. *Journal of Political Economy 117*(6), 1031–1073.

Rochet, J.-C. and X. Vives (2004). Coordination Failures and the Lender of Last Resort: Was Bagehot Right after All? *Journal of the European Economic Association 2*(6), 1116–1147.

Schmidt, L., A. Timmermann, and R. Wermers (2016). Runs on money market mutual funds. *American Economic Review 106*(9), 2625–57.

Schularick, M. and A. M. Taylor (2012). Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870–2008. *American Economic Review 102*(2), 1029–1061.

Tarullo, D. (2008). *Banking on Basel: The Future of International Financial Regulation*. Peterson Institute for International Economics.

Temin, P. (1976). *Did monetary forces cause the Great Depression?* Norton.

Tufts, R. and G. Tufts (2001). Shareholder double liability and depositor losses in failed national banks: 1865–1935. *Moments in History: Office of the Comptroller of the Currency*.

van Belkum, L. (1968). *National Banks of the Note Issuing Period, 1863-1935*.

Walter, J. R. (2004). Closing troubled banks: How the process works. *FRB Richmond Economic Quarterly 90*(1), 51–68.

Wheelock, D. C. and P. W. Wilson (2000). Why do banks disappear? the determinants of us bank failures and acquisitions. *Review of Economics and Statistics 82*(1), 127–138.

White, E. (1983). *The Regulation and Reform of the American Banking System*. Princeton University Press.

Wicker, E. (1996). *The banking panics of the Great Depression*. Cambridge University Press.

Wright, D. M. and J. V. Houpt (1996). An analysis of commercial bank exposure to interest rate risk. *Fed. Res. Bull. 82*, 115.

Failing Banks
Online Appendix

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August 28, 2024

- Appendix A: Evolution of the U.S. Banking System and Bank Failures
- Appendix B: Additional Tables and Figures
- Appendix C: Data Appendix

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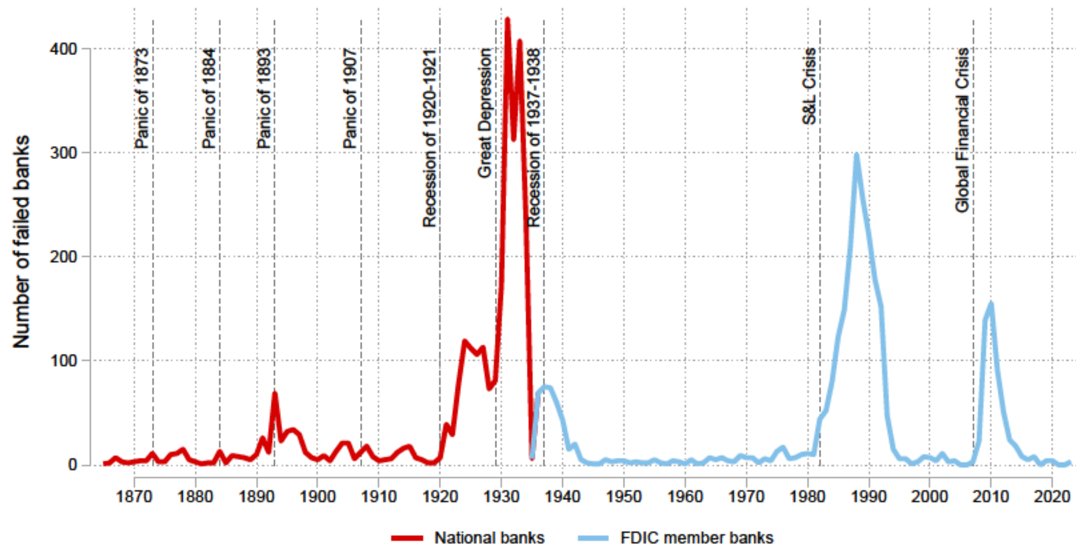
A Evolution of the U.S. Banking System and Bank Failures

This section charts the evolution of bank failures and banking regulation in the U.S. since 1865. Figure 1 in the paper shows failure rate throughout our sample. Figure A.1 plots the number of failures. Table A.1 summarizes the key institutional and regulatory features by era.

Figure A.1: ***Failing Banks: 1865-2023***



Notes: This figure plots the number of failed banks by year. Vertical lines indicate selected major banking crises and economic downturns. The red line plots the number of failing national banks, defined as national banks placed into receivership. The blue line plots the number of banks classified as failed by the FDIC. We restrict our sample of FDIC member banks to National Member Banks, State Member Banks, and State Nonmember Banks and exclude Savings Associations, Savings Banks, and Savings and Loans.

National Banking Era Our sample begins at the start of the National Banking Era, which spans the period between the Civil War and the founding of the Federal Reserve System, roughly 1863 to 1913. It was preceded by what is now referred to as the Free Banking Era, during which banks could charter under state laws after fulfilling a simple set of regulatory requirements. Since the United States did not have a central bank for most of the nineteenth century, these state-chartered banks were the main issuers of notes in circulation. To be able to issue bank notes, banks had to cover their note issuance with purchases of state-issued government bonds. This changed during the Civil War, when the federal government needed to finance the war. To increase demand for federal government bonds, Congress passed two laws (the National Currency Act in 1863 and the National Banking Act in 1864) that allowed banks to be chartered under federal law—thus the name: national banks. Like state banks before them, national banks were allowed to issue bank notes when backed by government bonds. Currency issued by state banks was taxed at a high rate that encouraged banks to adopt national charters and purchase federal government bonds. The National Banking Act also established a regulatory and supervisory authority, the Office of the Comptroller of the Currency (OCC). The OCC published national bank balance sheets every year in an annual report to Congress, as discussed in the data section. Although the National Banking Era started in 1863, the 1863-64 OCC Annual Reports did not provide bank-level balance sheet information at the same detail as subsequent years.

Other than issuing currency, national banks operated very much as banks do today, by taking deposits and making loans. However, there was very little government interference. For instance, there was no insurance for deposits. Moreover, as there was no central bank, there was also no lender of last resort to help banks in a crisis.[1] Thus, in this period, we can be reasonably confident that bank behavior was not driven by the anticipation of government support. Moreover, national banks were restricted to operating as unit banks, which meant that each bank could only operate a single branch serving a single location. Finally, capital regulation during the national Banking Era did not restrict the leverage ratio but reflected entry barriers (Carlson et al., 2022). At the founding of a bank, the bank charter would determine the dollar-amount of capital paid in to the bank with a minimum amount determined by the population of the bank's location. Thereafter, banks were largely able to choose their leverage freely subject to market conditions, though banks did face restrictions on dividend payouts based on their surplus. National banks were subject to double liability. In the event of failure, a receiver would levy an additional assessment on the bank shareholders' equal to the par value of subscribed capital to cover losses to depositors (Grossman, 2010). National banks were subject to double liability until 1937. National banks also faced portfolio restrictions limiting their capacity to lend against real estate collateral (White, 1983).

The National Banking Era witnessed a series of banking crises. The banking crisis chronology of Baron et al. (2021) records banking crises featuring widespread bank failures and panic-runs in 1873, 1884, 1890, 1893, and 1907.[2] For the National Banking Era, Figure 1 shows that the rate of failure of national banks was highest around the Panic of 1893.

Early Federal Reserve & Great Depression The recurring financial crises of the National Banking Era led to the creation of a central bank through the Federal Reserve Act of 1913. The Federal Reserve could serve as a lender of last resort and had the responsibility to supervise member banks.

The McFadden Act 1927 liberalized restrictions on national banks. Before the Act, national banks were prohibited from opening branches. The Act allowed national banks to branch in states where state banks were permitted to branch, a step toward liberalization of geographic restrictions (see, e.g., Rajan and Ramcharan, 2016). The McFadden Act also liberalized rules for Federal Reserve member banks to lend against real estate and expanded lending limits to single borrowers. Moreover, the McFadden act rechartered the Federal Reserve into perpetuity, removing the risk that the charter would be revoked,

[1] Treasury performed quasi-central bank operations toward the end of the National Banking Era, but the interventions were small (Friedman and Schwartz, 1963).

[2] See also Jalil (2015), who records 1873, 1893, and 1907 as "major" banking panics, defined as an increase in the demand to convert deposits into currency that leads to bank runs and bank suspensions.

Table A.1: *Evolution of the U.S. Banking System*

Era	Years	Deposit insurance	Central bank	Capital regulation	Geographic restrictions
National Banking Era	1863-1913	No	No	$ by pop	Unit-branch**
Early Federal Reserve	1914-1928	No*	✓	$ by pop	Unit-branch**
Great Depression	1929-1935	No*	✓	$ by pop	Local branching
Boring Banking	1959-1982	✓	✓	Supervisory Discretion	Local branching
				Leverage ratio in 1985	
Deregulation and S&L	1982-2006	✓	✓	Basel I in 1989	Limited until 1994
Global Financial Crisis	2007-2015	✓	✓	Basel II/III + DFAST	No
Post-crisis	2015-	✓	✓	Basel II/III + DFAST	No

Notes: *There was no deposit insurance for national banks until the founding of the Federal Deposit Insurance Corporation (FDIC) in 1933. However, selected states implemented deposit insurance schemes for state-chartered banks already before 1933 (see Calomiris and Jaremski, 2019). ** Local branching was permitted for state banks in selected chartered states. National banks were not allowed to branch until the McFadden Act of 1927. This Act allowed national banks to branch in states in which state-chartered institutions were permitted to branch.

as had occurred with the First and Second Banks of the United States.

The 1920s witnessed a rise in banking failures. Failures were concentrated in agricultural states and primarily affected small, rural banks. The rise in bank failures was driven by a sharp decline in agriculture and land prices in agrarian states, as well as rising urbanization that weakened the position of rural banks (Friedman and Schwartz, 1963). Figure 1 shows that the failure rate of national banks reached a new high in the 1920s, even before the Great Depression.

The Great Depression further exacerbated distress among banks, and several scholars have argued that the banking crisis, in turn, contributed to the severity of the downturn (e.g., Friedman and Schwartz, 1963; Bernanke, 1983). The wave of bank failures prompted a decades-long debate about whether failures were mainly liquidity-based due to depositor runs (Friedman and Schwartz, 1963) or driven by fundamentals such as rising losses (Calomiris and Mason, 2003). Richardson and Troost (2009) exploit that the Atlanta and St. Louis Federal Reserve banks followed different lender of last resort policies and find that Fed liquidity reduced bank failures and boosted lending, pointing to a role for liquidity-based failures. This also highlights that lender of last resort facilities were not uniformly available, even with a central bank, especially as the discount window became stigmatized.

The Great Depression prompted a wave of banking reforms. Deposit insurance was introduced in 1933 and then made permanent in 1934 with the creation of the FDIC.[3] Great Depression banking reform also imposed a range of limits of banking activities (Kroszner and Strahan, 2014). The Glass-Steagall Act prohibited commercial banks from engaging in investment banking activities (corporate bond and equity underwriting).

[3]State level deposit insurance systems had existed before, but these became inoperative by Great Depression (Calomiris and Jaremski, 2019). State-level deposit insurance schemes did not apply to national banks.

It also imposed limits on interest rates that banks could pay on deposits, known as Regulation Q (Gilbert, 1986).

The Great Depression brought an end to shareholder double liability. The Banking Act of 1933 allowed for the issuance of shares without double liability, and the Banking Act of 1935 allowed national banks to remove double liability from their shares in 1937 (Tufts and Tufts, 2001). Double liability was unpopular among bank shareholders following the high rates of failure during the Depression. It was also seen as ineffective in preventing bank failures and unnecessary with the advent of deposit insurance (Grossman, 2001).

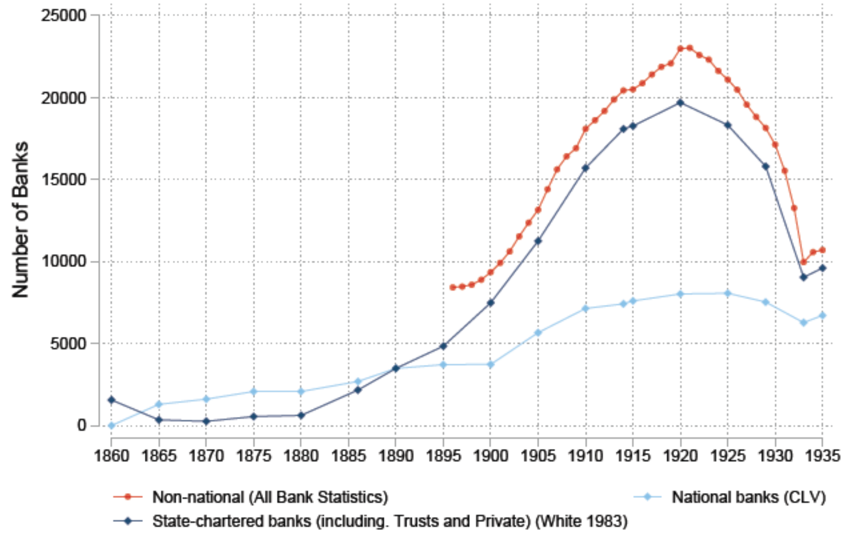
Some notes on the Dual Banking System In our analysis in the main paper, we rely entirely on data on national banks for the period prior to the founding of the FDIC. As noted in the main text, the main reason for focusing on national banks is the availability of consistent records provided by the OCC on both balance sheets and bank failures. However, it is important to highlight that the US banking system featured several types of financial institutions that were not chartered under federal law but state law. National banks always coexisted alongside state banks, trusts, and private banks, with the relative importance of each type of institution varying over time.

For instance, Figure A.2 plots the number of national banks and state-chartered institutions (panel (a)) and their market share of total banking assets (panel (b)). National banks had a very large market share of the entire banking market ranging of around 80% at the onset of the National Banking Era. This large market share is related to the fact that the National Banking Act imposed a tax on notes issued by state banks, making state bank charters very unattractive. However, starting in the 1880s, the rise as of deposits as form of money, slowly eroded the advantage of national bank's to issue notes. Thus, over time the market share of national banks started to shrink, reaching 45% by the 1930s. More generally, state-chartered institutions tended to be active in smaller markets in which national banks, which faced considerable stricter regulatory requirements, were not viable. Hence, state banks tended to be smaller in size, but there tended to be more state banks than national banks. This naturally implies that national banks tended to have larger, more financially sophisticated depositors than state banks.

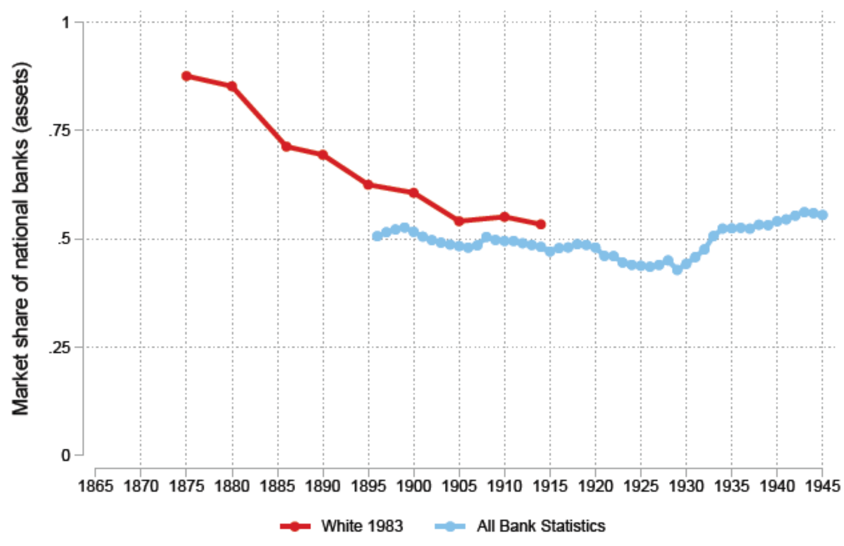
While Figure 1 in the main text plots the failure rate (receivership) of national banks, Figure A.3 plots the suspension and receivership rates for national banks and suspension rates for state-chartered institutions. Observe that before 1892, there is no reliable source of state bank suspensions and receivership. After 1892, it become possible to construct a series for both. Figure A.3 shows that failure rates co-moved broadly, with state banks facing slightly higher failure rates than national banks. However, note that the counts of state-chartered institutions changed across sources (differing in the inclusion of trusts, mutual banks, and private institutions), making it *de facto* impossible to construct on consistent time series of failure rates across all bank types. Hence, the levels of failure rates before and after 1920 are not comparable across time.

Figure A.2: *Number of Banks by Type and the Market Share of National Banks*

(a) *Number of banks*

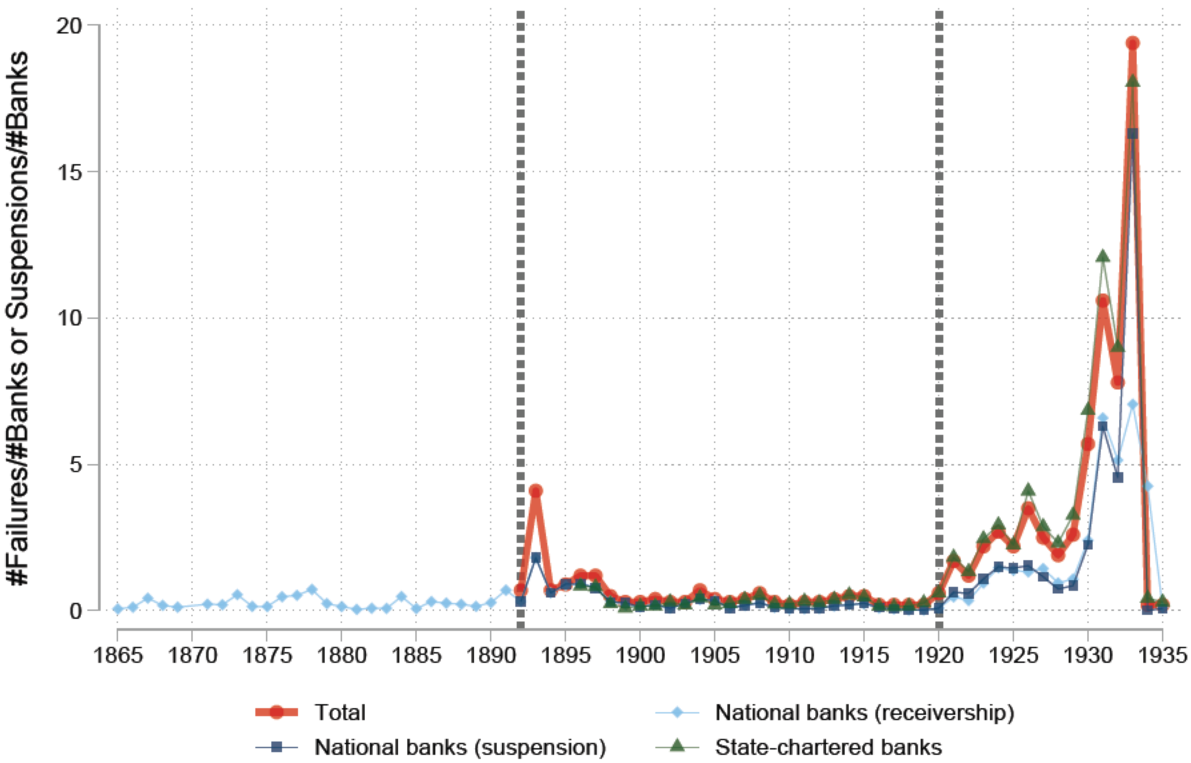


(b) *Market share of national banks based on total assets*



Notes: Data on state banks, trusts, and private bank are as indicated in the legend either taken from White (1983) and "All Bank Statistics" digitized by Flood (1998). State bank assets are available from 1875 onwards in White (1983); assets of trusts and private bank from 1886 onwards in "All Bank Statistics". Number of national banks in panel (a) are taken from the sample used in this paper.

Figure A.3: *Bank Failures and Suspensions by Bank Type*



Notes: This figure combines various sources to construct a rate of bank failure from 1865 through 1935 for national banks, state-chartered banks, and all banks combined. From 1865-1891, we use the U.S. Comptroller of the Currency Annual Report list of failed banks. From 1892-1920, the number of bank suspensions are from Chapter X of the "Historical statistics of the United States, Colonial Times to 1957" (available here). For 1921-1934, data are the Board of Governor's from "Bank Suspensions, 1892 - 1935" (available at here). Note that differences in sources between 1864 and 1892, 1892-1920, and 1921-1934 complicate comparisons across time.

Boring Banking We refer to the era from 1959 through 1982 as the "Boring Banking" Era. The term "Boring Banking" is inspired by Paul Krugman, who wrote in the New York Times on April 9, 2009: "Thirty-plus years ago, when I was a graduate student in economics, only the least ambitious of my classmates sought careers in the financial world. Even then, investment banks paid more than teaching or public service - but not that much more, and anyway, everyone knew that banking was, well, boring." During this era, failure rates were low. Banks' activities were restricted by the Depression-era regulations. Furthermore, the 1956 Bank Holding Company Act allowed states to restrict entry by out-of-state banks and holding companies, which effectively prohibited interstate banking. There was no explicit capital requirements. Instead, capital regulation was conducted by supervision, and supervision focused not just on capital ratios but on a broader range of quantitative and qualitative factors (Haubrich, 2020).

Rising inflation and interest rates led to outflows of deposits from commercial banks and into money market funds that were not subject to interest rate ceilings. This led to a phasing out of interest rate ceilings on deposits with the 1980 Depository Institutions Deregulation and Monetary Control Act (Kroszner and Strahan, 2014).

Deregulation and Savings & Loan (S&L) Crisis The period of low bank failure rates came to an end in the with a rise in bank failures in the second half of the 1970s. Bank failures further increased in the 1980s. While the failures in the S&L crisis were highest among thrifts, commercial banks also saw high failure rates during 1980s (see Figure 1). The S&L crisis is often dated to 1984 based on the failure of Continental Illinois, which represented the largest bank failure in U.S. history at the time. Failures in the 1980s were driven by a combination of high interest rates, the severe recessions over 1980-1982, losses in oil and gas loans, and losses from exposure to the Latin American debt crisis.

In response to rising bank failures[4] and a trend of declining bank capital ratios discussed below, the 1980s witnessed the formal introduction of modern regulatory capital ratios that require a minimum amount of equity finance as a share of total assets. In the early 1980s, both the OCC and the Federal Reserve communicated a simple leverage ratio requirement of 5% equity finance and noted that banks falling short of this cutoff would be considered undercapitalized.[5] The International Lending Supervision Act (ILSA) of 1983 then formally required regulatory agencies to explicitly set capital ratios. By 1985, Federal Reserve, OCC, and the FDIC had formalized and published final regulations similar to those of the original 1981 guidelines.

Following this period of formalizing capital regulation, capital requirements based on risk-weighted assets also became increasingly popular. In the 1950s, the Federal

[4]Rising inflation and interest rates led to outflows of deposits from commercial banks and into money market funds that were not subject to interest rate ceilings. This also led to a phasing out of interest rate ceilings on deposits with the 1980 Depository Institutions Deregulation and Monetary Control Act (Kroszner and Strahan, 2014).

[5]Both the Federal Reserve and the OCC published numerical capital ratios in 1981. According to Tarullo (2008), the agencies in effect adopted a minimum requirement of capital-to-assets of 5%. The FDIC only published guidelines on "minimum acceptable levels" of primary capital. The original published requirements excluded the 17 largest banks (those with $15B or more in assets) but by June 1983, these banks were also included.

Reserve developed its Analyzing Bank Capital (ABC) model, which was an early method to construct a capital ratio based on risk-weighted assets. The S&L Crisis also led Congress to pass the FDIC Improvement Act in 1991. A key provision of this Act was the introduction of Prompt Corrective Action (PCA), which requires supervisors avoid exercising forbearance and to take increasingly severe actions when a bank is deemed to be undercapitalized.

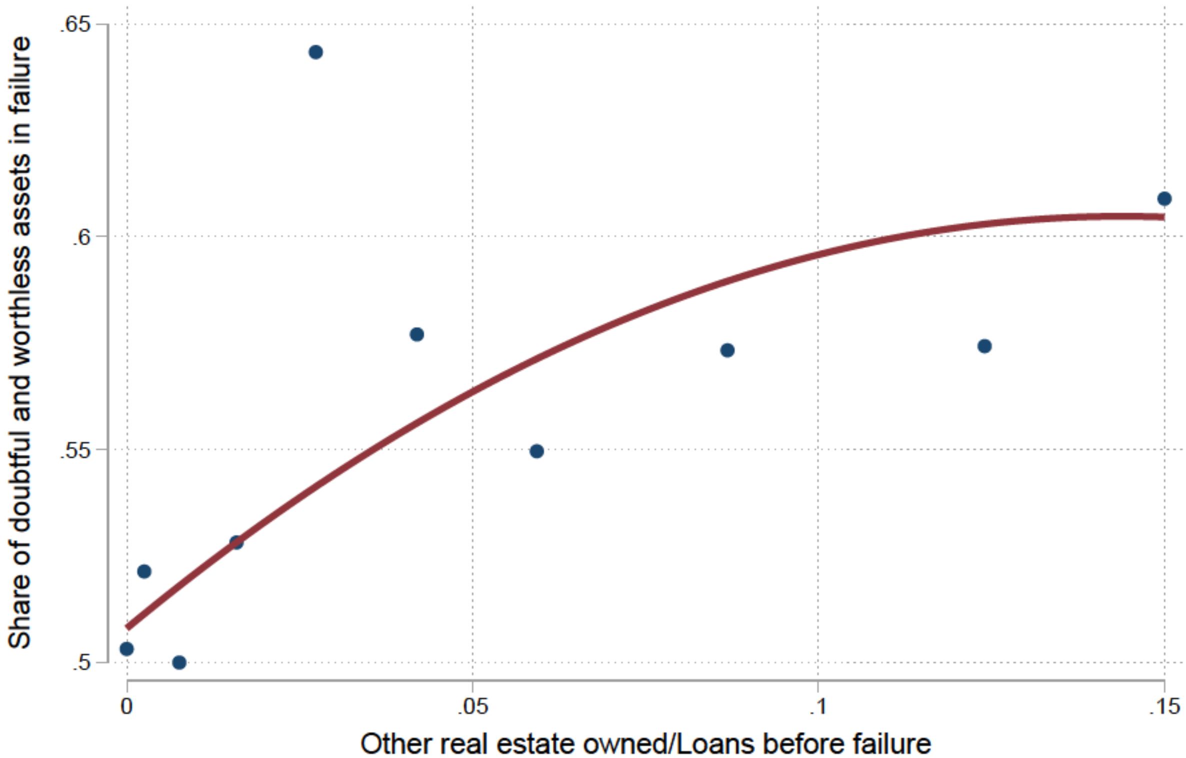
At the same time, there was a move toward levelling the international playing field for banks. To this end, the Basel I accord was finalized in 1988 and implemented in the U.S. in 1991. Basel I introduced a minimum capital requirement of 8% based on risk-weighted assets. Risk-weight varied from 0% for supposedly risk-free assets such as cash up to 100% for the most illiquid and risky forms of bank lending such as corporate debt. Further, to address various practical issues around the implementation of Basel I was revised and followed by Basel II in 2007. The Basel II framework left the overall required amount of capital unchanged but allowed for the possibility of banks opting into using their own internal risk models rather than the simple risk weights provided in Basel I. Moreover, Basel II attempted to address issues around off-balance sheet exposures that allowed for an effective circumvention of capital requirements.

Global Financial Crisis and Beyond Finally, the Global Financial Crisis (GFC) initiated additional drastic changes in regulation and supervision of financial institutions. Basel III and the Dodd-Frank Act led to both more stringent and more complicated capital requirements. Capital ratios were increased relative to Basel II and the definition of what constitutes capital was tightened. Capital requirements became differentiated by bank, with the tighter requirements for the largest banks, the Global Systemically Important Banks. Basel III also introduced a capital conservation buffer, limiting bank payouts when capital falls close to the minimum capital ratios, and a counter-cyclical capital buffer (CCyB), which is set at the discretion of the Board of Governors of the Federal Reserve.

The aftermath of the GFC also saw the rise of stress testing. A stress test assesses whether banks are sufficiently capitalized to withstand adverse scenarios. Effectively, the stress test represents a form of a forward-looking, bank-specific capital requirement. In early 2009, at the height of the crisis, the Supervisory Capital Assessment Program (SCAP)—subsequently replaced by the Comprehensive Capital Analysis and Review (CCAR)—represented the first stress testing effort. SCAP aimed to ensure that the 19 largest banks had sufficient capital coming out of the crisis to absorb losses under poor economic conditions. The Dodd-Frank Act formalized regular stress tests for the largest banks (DFAST) in 2013. Under CCAR, each bank must propose a capital distribution plan incorporated into the stress test, whereas DFAST uses a standardized capital distribution plan that holds dividends at their current level and sets net repurchases to zero. DFAST also requires banks to run (and disclose) stress tests using the same set of inputs (i.e., the Fed's scenarios and the standard capital distribution plan) but with their own, internally developed model.

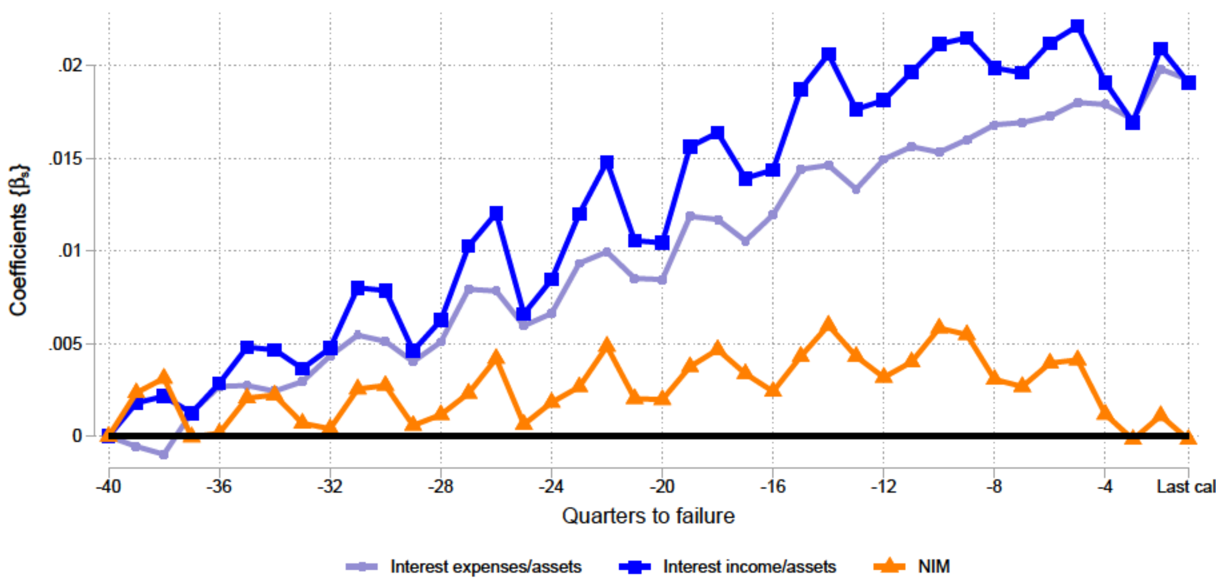
B Appendix Figures and Tables

Figure B.1: ***Other Real Estate Owned before Failure and Share of Doubtful and Worthless Assets in Failure***



Notes: This figure shows a binned scatter plot correlating the share of Other Real Estate Owned (OREO) a failing bank reports before failure as a share of its total outstanding loans before failure (x-axis) with the share of assets that the OCC classified as "doubtful" or "wortheless" after the bank failed (y-axis). Data for failing banks from 1889 through 1904.

Figure B.2: ***Interest Income, Expenses and NIM: 1959-2023***

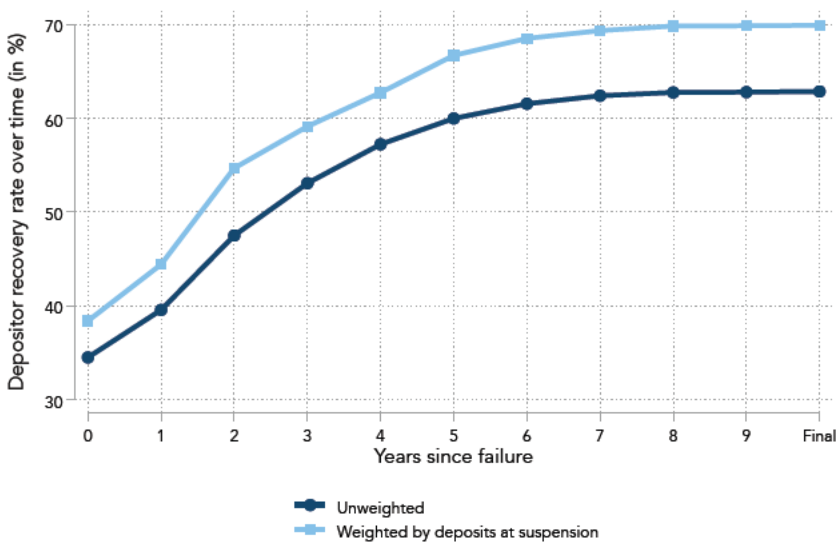


Notes: The figure shows the sequence of coefficients from a regression of the following form:

$$y_{b,t} = \alpha_b + \sum_{j=-10, j\neq-10}^{0} \beta_j \times \mathbf{1}_{j=t} + \epsilon_{b,t}$$

where y_{bt} is the ratio indicated in the figure legends, and α_b is a set of bank fixed effects. The sample is restricted to failing banks and to the ten years before they fail and banks that fail after 1959. The net interest margin (NIM) is defined as the difference of total interest income net of interest expenses normalized by total assets.

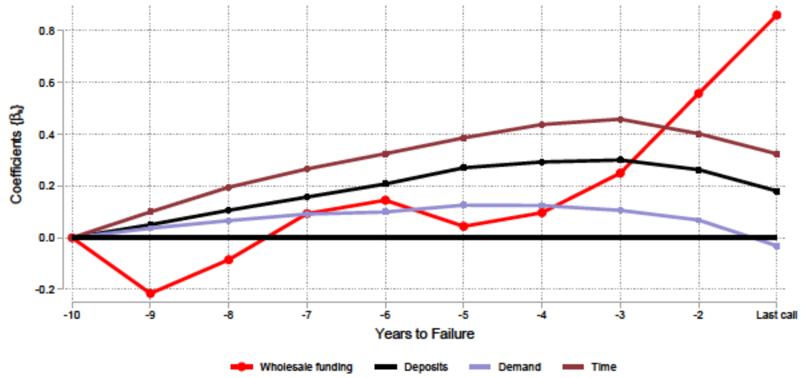
Figure B.3: ***Deposit Recovery Rate over Time Following Bank Failure: 1920-1939***



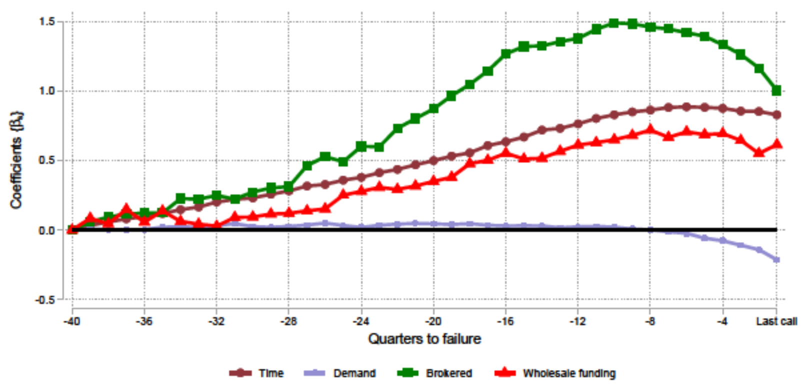
Notes: The figure shows the average depositor recovery rate as a function of the time since failure. The sample covers bank failures from 1920 to 1939, as this sample allows us to observe the dividend payments to depositors in each year from the suspension to when the bank is finally closed. Data are collected from the OCC's annual report to Congress; tables on "National banks in charge of receivers" (various years).

Figure B.4: *Funding of Failing Banks: Outcomes in Natural Logarithms*

(a) *1865-1934: Deposits and Wholesale Funding*



(b) *1959-2023: Time, Demand, and Brokered Deposits, and Wholesale Funding*

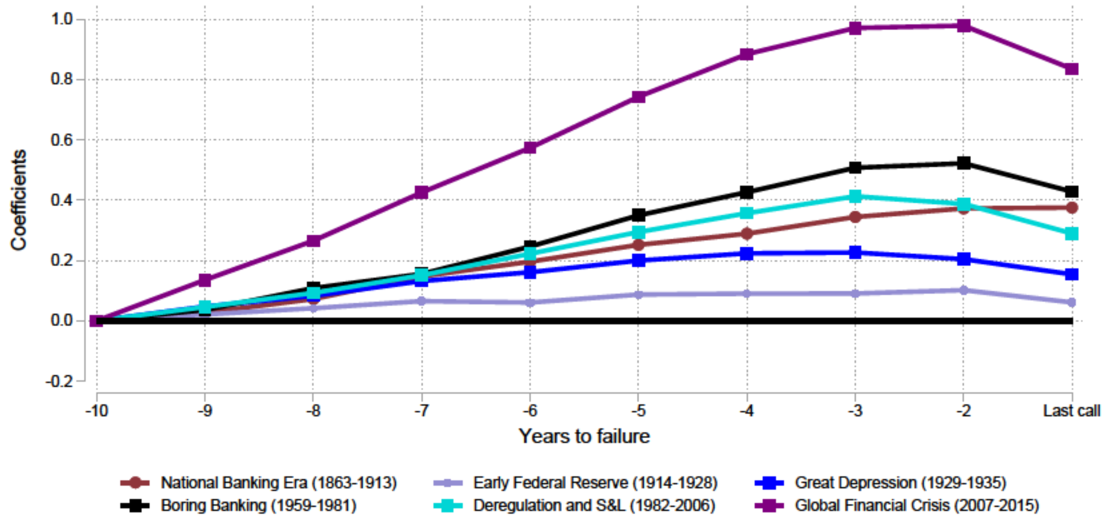


Notes: The figure shows the sequence of coefficients from a regression of the following form:

$$y_{b,t} = \alpha_b + \sum_{j=-10, j\neq -10}^{0} \beta_j \times \mathbf{1}_{j=t} + \epsilon_{b,t}$$

where y_{bt} is the natural logarithm of the line item indicated in the figure legends and α_b is a set of bank fixed effects. The sample is restricted to failing banks and to the ten years before they fail. In panel (a), the sample is restricted to data from 1865 though 1934 and in panel (b) to data from 1959 through 2023.
In panel (a) wholesale funding is defined as the sum of "Bills Payable" and "Rediscounts". In panel (b), wholesale funding is the amount reported in the call report line item "other borrowed money" which pools various sources of bank wholesale funding, such as advances from Federal Home Loan Banks (FHLBs), other types of wholesale borrowings in the private market, and credit extended by the Federal Reserve.

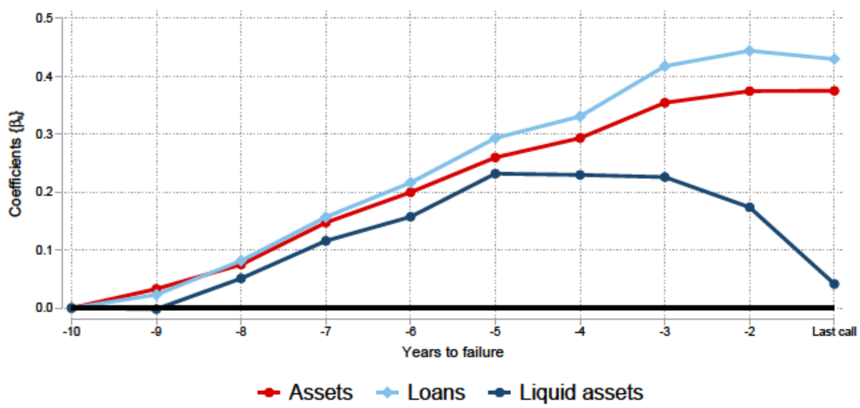
Figure B.5: *Assets in Failing Banks: 1863-2023, By Historical Subsamples*



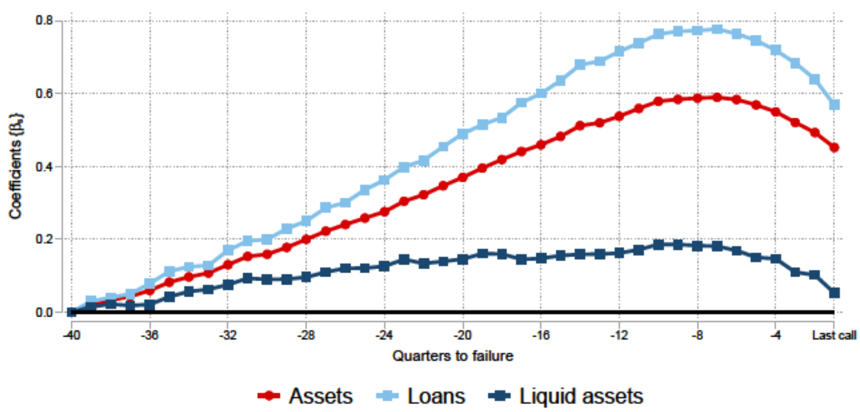
Notes: This figure reports the sequence of coefficients from estimating Equation (1) with log total assets (deflated by CPI) as the dependent variable for various subsamples. The regression includes a set of bank fixed effects. The sample is restricted to failing banks and to the ten years before they fail. The sub-samples indicated in the figure legends are selected based on the years in which a bank failed.

Figure B.6: ***Liquid and Illiquid Assets in Failing Banks***

(a) *1865-1935*

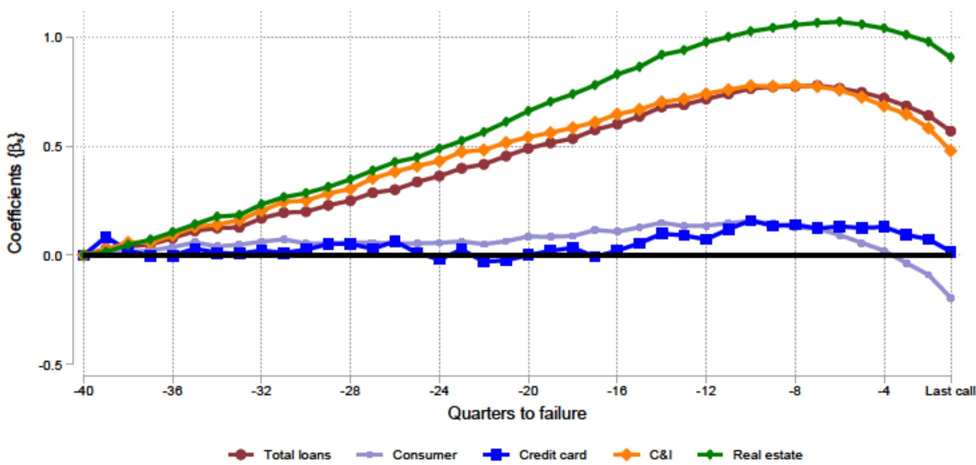


(b) *1959-2023*



Notes: This figure plots the sequence of coefficients from estimating Equation (1) with the logarithm of either assets, loans, or liquid assets (all deflated by the CPI) as the dependent variable for different samples. The specification includes a set of bank fixed effects. The sample is restricted to failing banks and to the ten years before they fail. From 1865 through 1941, we define liquid assets as the sum of currency, checks, legal tender, interbank claims, bonds to secure deposits and bonds on hand, and bills of national banks and state banks. From 1959 onwards, liquid assets are defined as currency and reserves held, balances with other banks, cash items in collection, and security holdings (both government-issued and private label).

Figure B.7: ***Asset Growth in Failing Banks is Driven by Real Estate and C&I Lending***

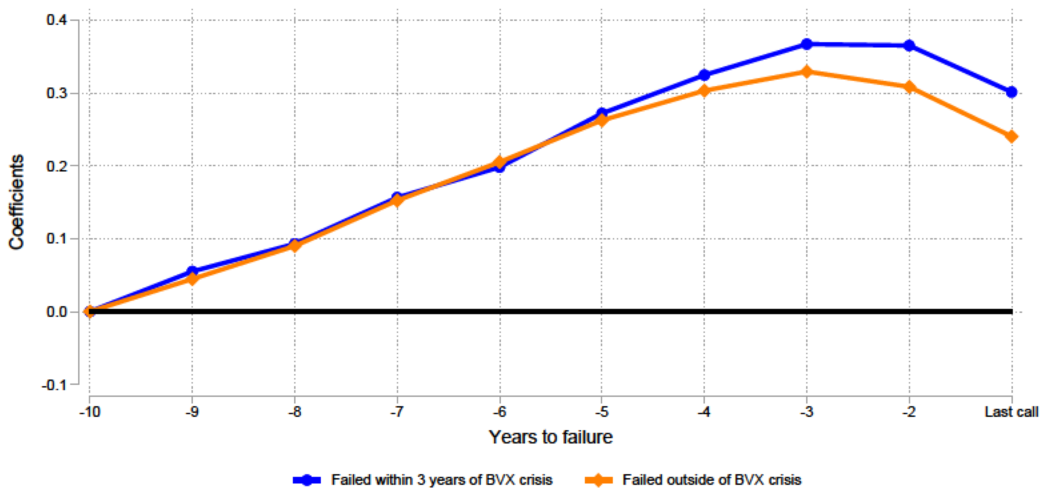


Notes: This figure presents the sequence of coefficients from a regression of the following form

$$y_{b,t} = \alpha_b + \sum_{j=-10, j\neq -10}^{0} \beta_j \times \mathbf{1}_{j=t} + \epsilon_{b,t},$$

where y_{bt} is a type of bank loan. The same is restricted to failing banks and to the ten years before they fail. The estimates are based on the post-1959 sample. Data on loan types is not available for the pre-1935 sample.

Figure B.8: *Asset Growth in Failing Banks for Failures Occurring during Financial Crises versus Normal Times*

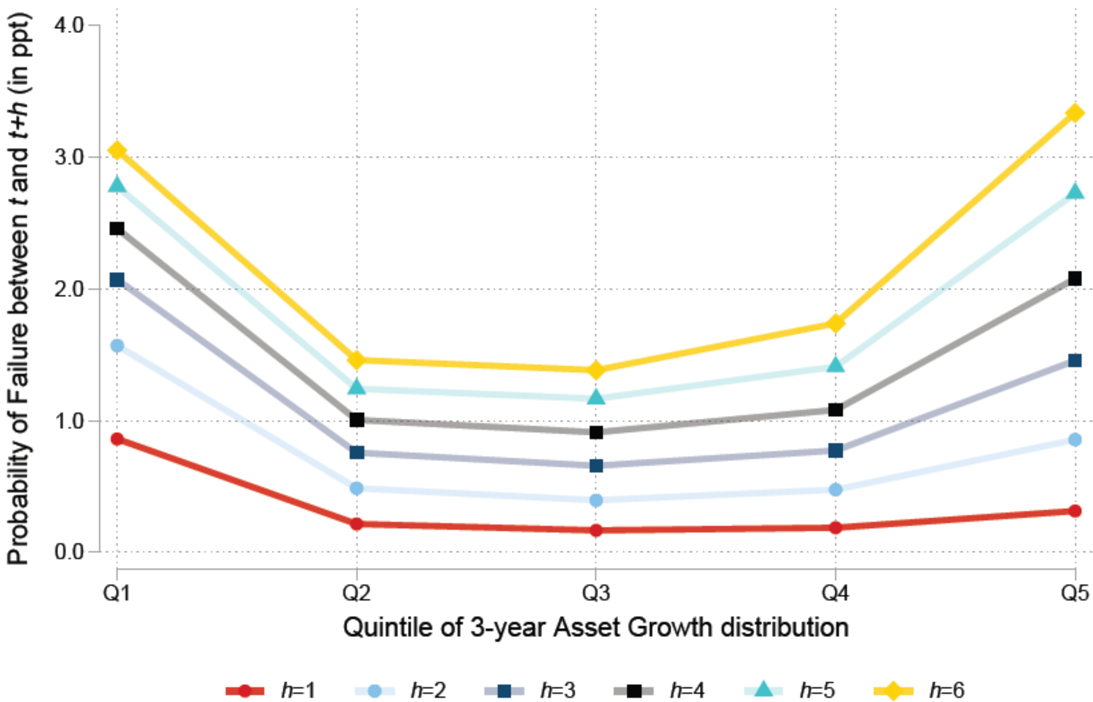


Notes: Both panels shows the sequence of coefficients from a regression of the following form:

$$y_{b,t} = \alpha_b + \sum_{j=-10, j\neq -10}^{0} \beta_j \times \mathbf{1}_{j=t} + \epsilon_{b,t}$$

where y_{bt} is either bank b' assets, deposits, or loans and α_b is a set of bank fixed effects. The sample is restricted to failing banks only and to the ten years before they fail. Financial crises are defined according to Baron et al. (2021)

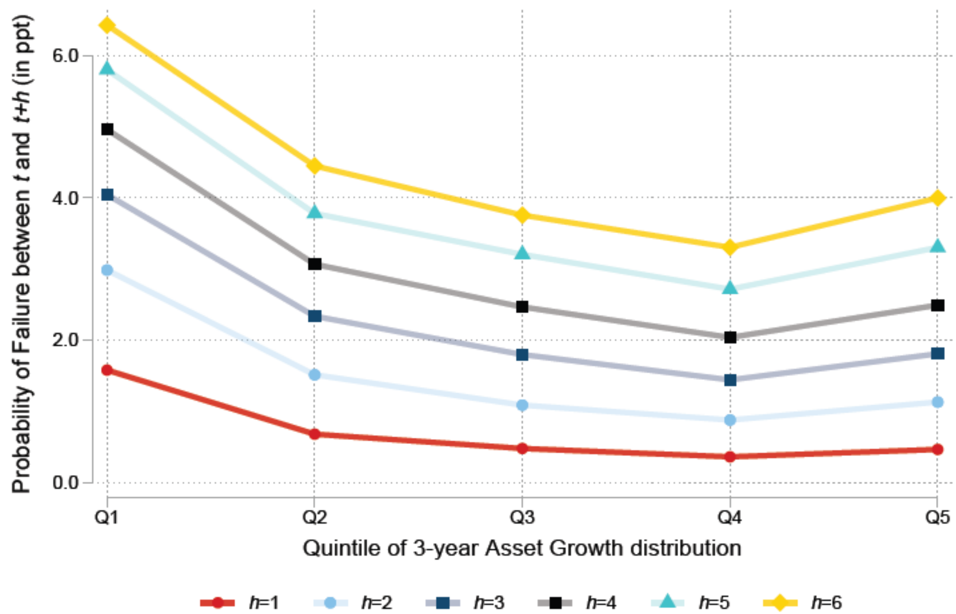
Figure B.9: *Failure Probability in the Cross-Section of Asset Growth*



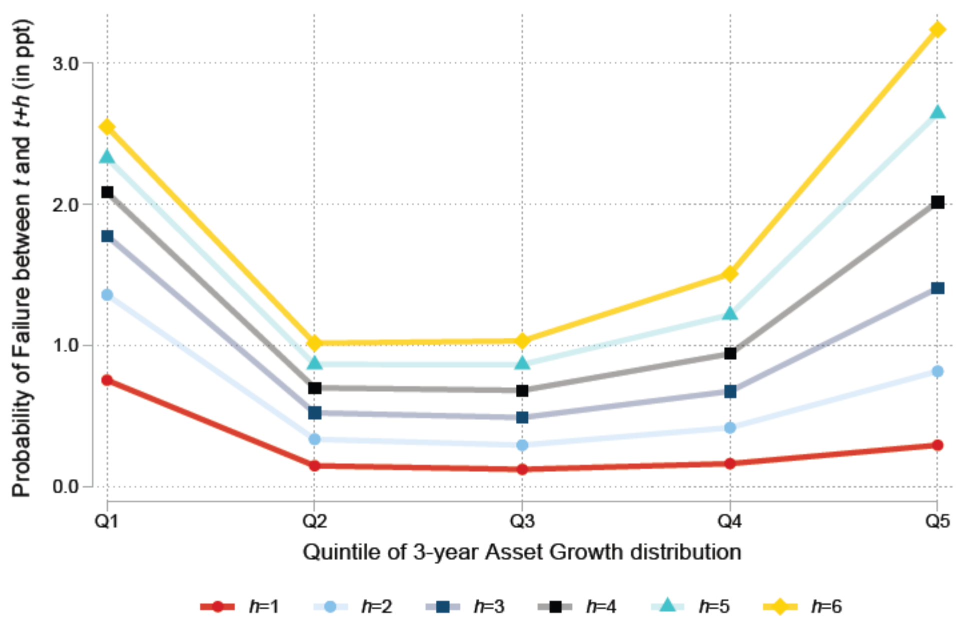
Notes: This figure plots the frequency of failure at the one to six year horizons across quintiles of the three-year asset growth distribution. Appendix Figure B.10 shows this figure separately for the pre- and post-FDIC samples.

Figure B.10: *Non-Monotonic Intertemporal Relation between Growth and Failure Probability*

(a) *Pre-1935*

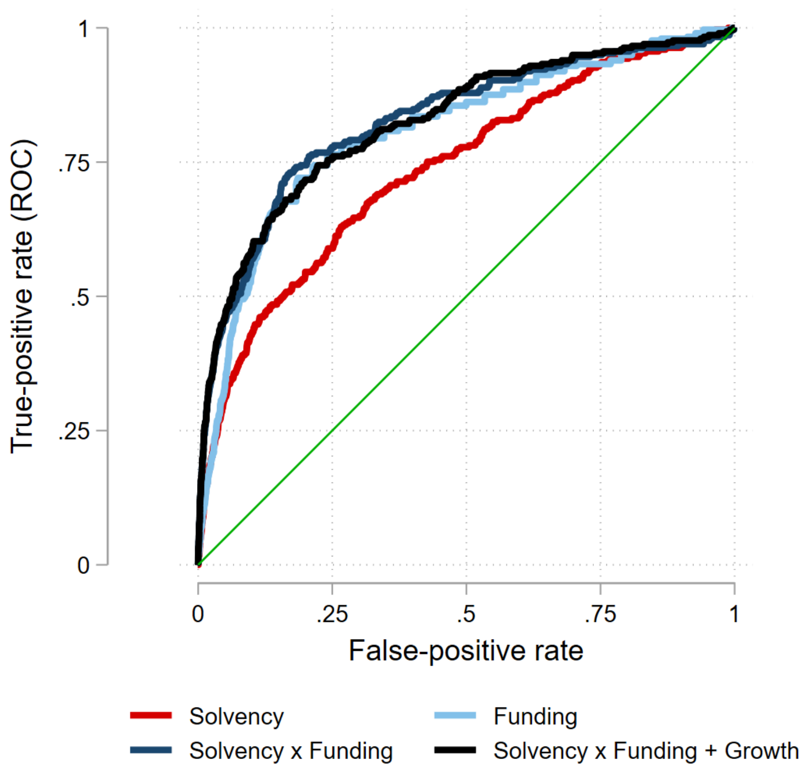


(b) *Post-1935*



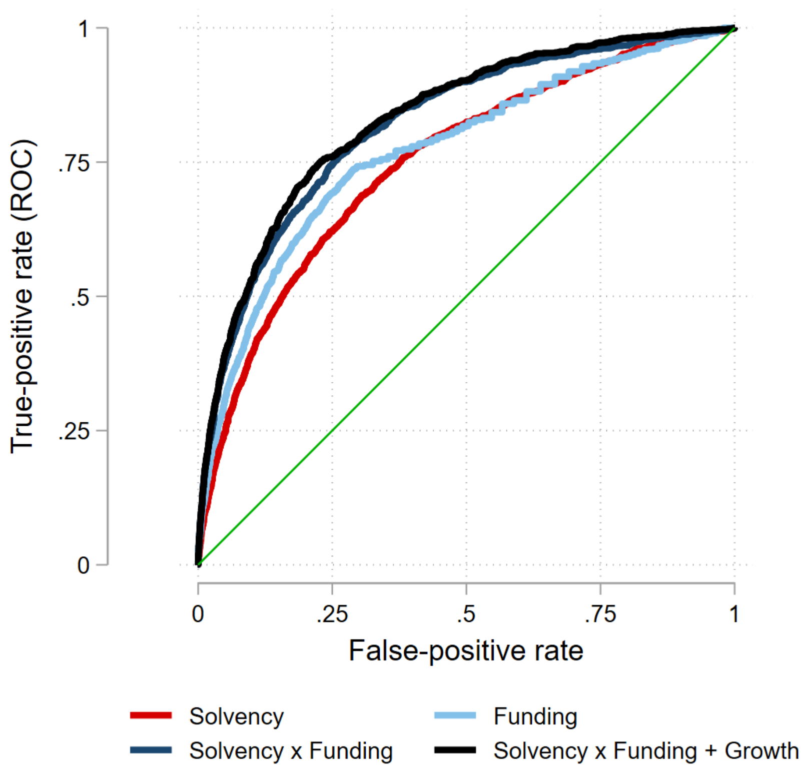
Notes: This figure plots the frequency of failure at the one to six year horizons across quintiles of the three-year asset growth distribution. Panel (a) presents the results for the 1865-1935 sample, and panel (b) presents the results for the 1959-2023 sample.

Figure B.11: *ROC Curves: 1870-1904 Sample*



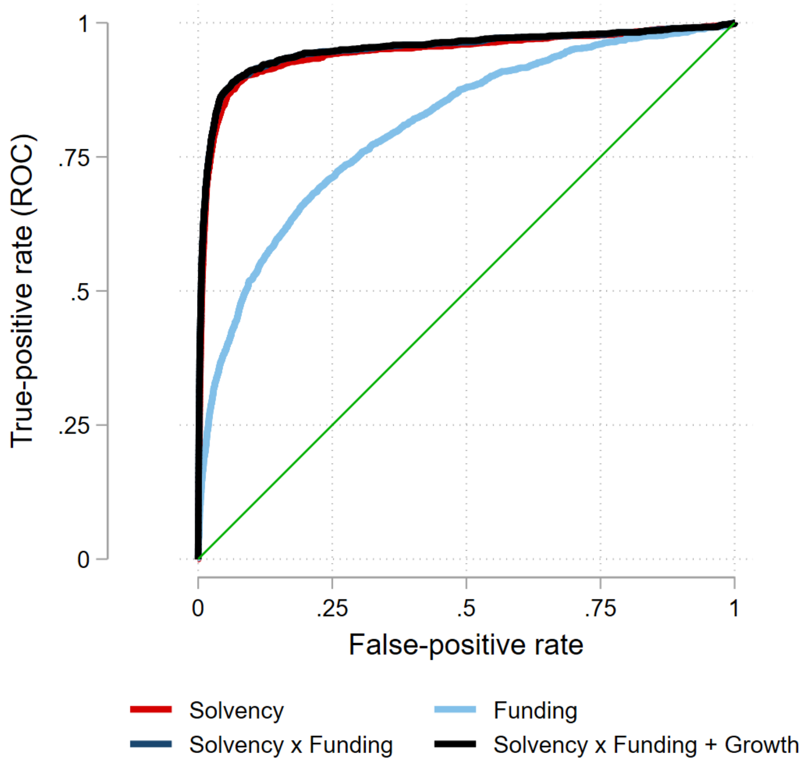
Notes: This figure plots the receiver operating characteristic (ROC) curve for the estimates based on columns (1) through (4) of Table B.6.

Figure B.12: ***ROC Curves: 1929-1935 Sample***



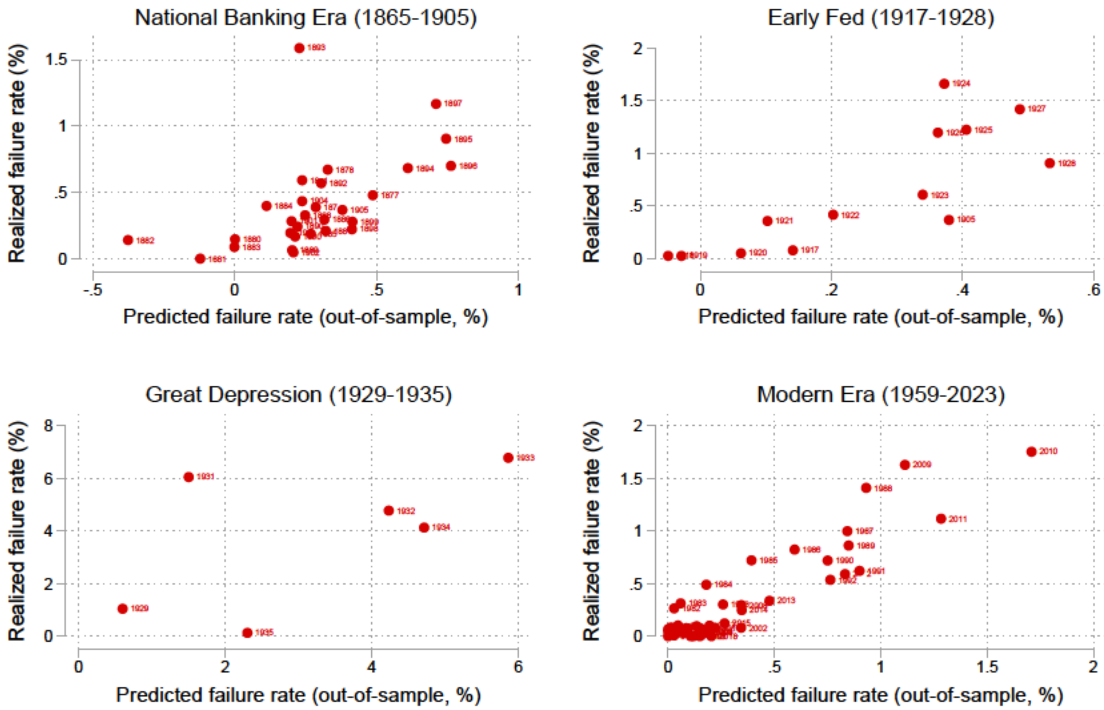
Notes: This figure plots the receiver operating characteristic (ROC) curve for the estimates based on columns (1) through (4) of Table B.8.

Figure B.13: ***ROC Curves: 1959-2023 Sample***



Notes: This figure plots the receiver operating characteristic (ROC) curve for the estimates based on columns (1) through (4) of Table B.9.

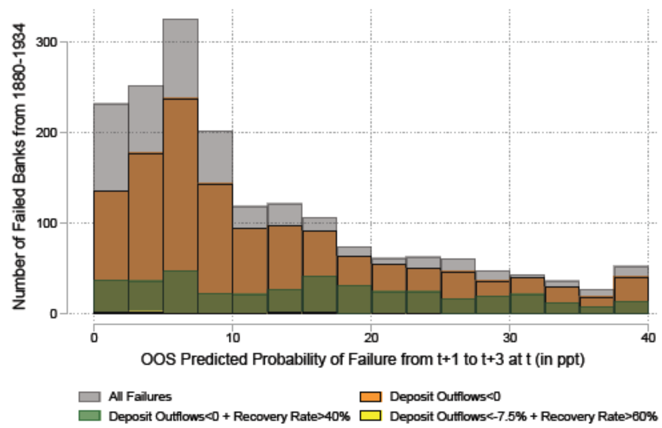
Figure B.14: ***Fundamentals Predict Aggregate Waves of Bank Failures***



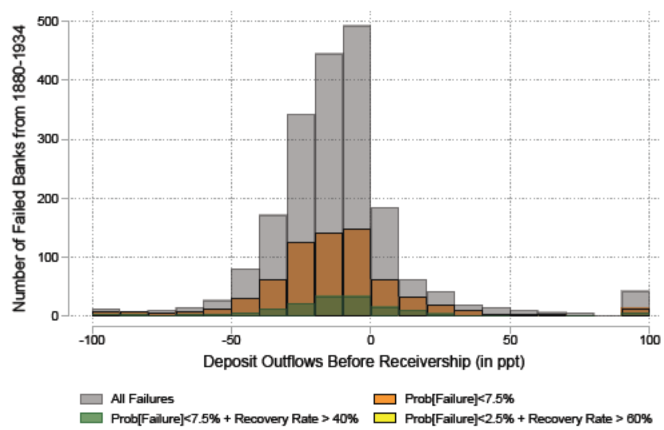
Notes: This figure plots the the realized bank failure rate against the out-of-sample predicted failure rate separately by era.

Figure B.15: ***Number of Pre-FDIC Failures by Predictability, Deposit Outflows, and Asset Recovery Rate.***

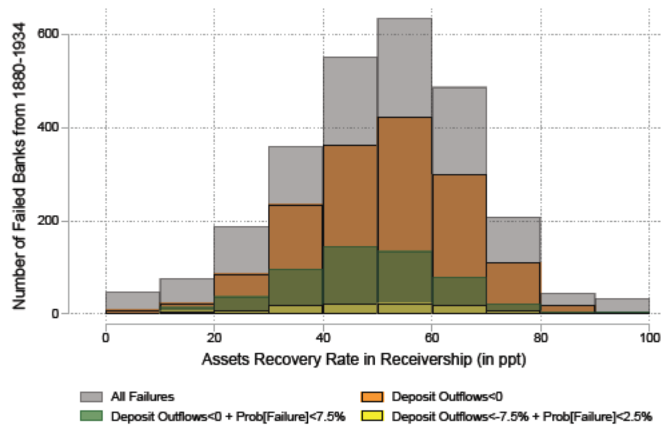
(a) *Frequency of Failures by Predictability*



(b) *Frequency of Failures by Deposit Outflows*



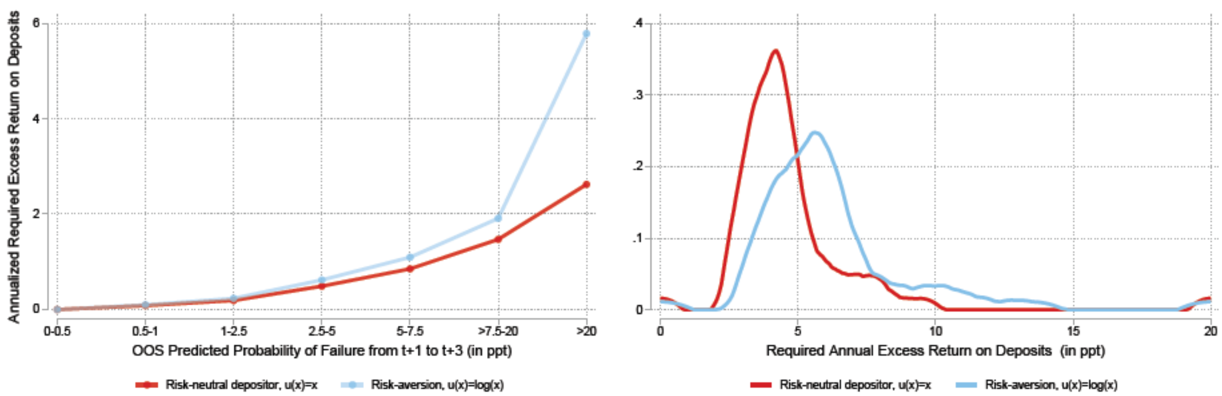
(c) *Frequency of Failures by Recovery Rate*



Notes: This figure plots the number of bank failures by out-of-sample predicted probability of failure over three year right before failure (panel (a)), by the recovery rate of assets held in receivership (panel (b)), and deposit outflows between last call report and in failure (panel (c)). We clip the out-of-sample predicted probability of failure at 40 ppt.

Figure B.16: *Implied Required Excess Returns for the pre-FDIC sample.*

(a) *Required Returns by OOS predicted failure probability* **(b)** *Required returns for $\hat{p} > 20\%$*



Notes: The left panel shows the required excess return on deposits by out-of-sample predicted probability of failure over three years. The right panel plots the distribution of the required excess return on deposits (winsorized at 50%) for bank with a predicted probability of failure of larger than 20%. We calculate the required return on deposits, $s_{b,t}$, as the solution to the following equation:

$$(1 - \hat{p}_{b,t+1|t})u(1 + r_t + s_{b,t}) + \hat{p}_{b,t+1|t}u(1 - \ell_{t+1|t}) = u(1),$$

where $\ell_{t+1|t}$ is the loss rate on failures up to time t and r_t is the rate on treasury bills in year t. For risk-neutral depositors, we assume $u(x) = x$, and for risk-averse borrowers we assume $u(x) = ln(x)$.

Table B.1: ***Summary Statistics: Bank-level Data from 1865 through 1941***

	N	Mean	Std. dev.	1st	10th	25th	75th	90th	99th
Failing bank	371,856	0.18	0.38	0.00	0.00	0.00	0.00	1.00	1.00
Equity/assets	336,810	0.23	0.13	0.06	0.10	0.13	0.31	0.43	0.59
Loans/assets	336,154	0.52	0.23	0.12	0.30	0.42	0.64	0.71	0.81
Deposits/assets	330,957	0.62	0.20	0.12	0.33	0.49	0.79	0.86	0.92
Liquid assets/assets	249,584	0.18	0.10	0.04	0.08	0.12	0.23	0.31	0.50
NPL/loans	63,126	0.02	0.04	0.00	0.00	0.00	0.01	0.05	0.18
Wholesale funding/assets	175,792	0.01	0.04	0.00	0.00	0.00	0.00	0.04	0.18
Dividend payouts restricted	191,798	0.04	0.21	0.00	0.00	0.00	0.00	0.00	1.00
3-year asset growth	339,674	0.00	0.69	-1.96	-0.77	-0.31	0.31	0.78	1.95

Notes: This table reports summary statistics for the bank-level data based on the OCCs annual report. Data are at annual frequency.

Table B.2: ***Summary Statistics: Bank-level Data from 1959 through 2023***

	N	Mean	Std. dev.	1st	10th	25th	75th	90th	99th
Failing bank	2,476,889	0.06	0.24	0.00	0.00	0.00	0.00	0.00	1.00
Equity/assets	2,476,851	0.10	0.07	0.04	0.06	0.07	0.11	0.14	0.35
Loans/assets	2,476,851	0.55	0.16	0.11	0.34	0.45	0.66	0.75	0.88
Deposits/assets	2,476,851	0.86	0.10	0.44	0.79	0.85	0.91	0.92	0.94
Liquid assets/assets	2,476,427	0.37	0.16	0.05	0.16	0.25	0.47	0.58	0.78
Loans/assets	2,476,851	0.55	0.16	0.11	0.34	0.45	0.66	0.75	0.88
Deposits/assets	2,476,851	0.86	0.10	0.44	0.79	0.85	0.91	0.92	0.94
Liquid assets/assets	2,476,427	0.37	0.16	0.05	0.16	0.25	0.47	0.58	0.78
Time deposits/assets	2,436,345	0.36	0.16	0.00	0.12	0.25	0.48	0.55	0.67
Wholesale funding/assets	2,476,850	0.01	0.04	0.00	0.00	0.00	0.00	0.04	0.18
Brokered deposits/assets	1,461,610	0.01	0.08	0.00	0.00	0.00	0.00	0.03	0.22
Net income/assets	1,910,708	0.01	0.01	-0.03	0.00	0.00	0.01	0.01	0.02
NPL/loans	1,354,217	0.02	0.03	0.00	0.00	0.00	0.02	0.04	0.12
LLP/loans	1,787,708	0.00	0.52	-0.00	0.00	0.00	0.00	0.01	0.04
NIM	1,905,796	0.01	0.02	-0.02	-0.00	0.00	0.02	0.03	0.05
3-year asset growth	2,138,777	0.14	0.31	-0.37	-0.11	-0.01	0.22	0.41	1.31

Notes: This table reports summary statistics for the bank-level data based the FFIEC Call Report. Net income, Loan Loss Provisions (LLP), and net interest income are based on annual, end-of-year data. All other variables are quarterly. The net interest margin is calculated as the ratio of net interest income over total assets.

Table B.3: ***Asset and Deposit Recovery Rates, 1863-1939***

Dependent variable	Asset recovery	Deposit recovery
	(1)	(2)
Good	0.78***	
	(0.01)	
Doubtful	0.45***	
	(0.01)	
Worthless	0.10***	
	(0.01)	
Asset recovery		1.13***
		(0.01)
Recovered form Shareholders		0.84***
		(0.12)
N	2617	2479
R^2	0.94	0.90

Notes: This table presents regressions explaining the asset recovery and deposit recovery rates. Each observation is a bank failure. Column (1) shows results from estimating the following regression:

$$\begin{aligned}\text{Total collected funds}_b = & \beta_1 \times \text{Assessed good}_b \\ & + \beta_2 \times \text{Assessed doubtful}_b \\ & + \beta_3 \times \text{Assessed worthless}_b + \epsilon_b,\end{aligned}$$

where all variables are normalized by total assets at the time of failure and all right-hand-side variables correspond to the assessment of the receiver in a failed bank.
Columns (2) shows results for estimating:

$$\begin{aligned}\frac{\text{Paid out to depositors}}{\text{Deposits at suspension}}_b = & \beta_1 \times \text{Total collected funds}_b + \\ & \beta_2 \times \text{Collected from Shareholders}_b + \epsilon_b,\end{aligned}$$

where Collected from Shareholders refers to the funds the receiver collects from shareholders after double liability is enforced. All right-hand-side variables are normalized by total assets at the time of failure. The sample covers failures from 1863 to 1939.

Table B.4: ***Loss Rates for Uninsured Depositors in Bank Failures: Pre-FDIC versus Post-FDIC***

Era	Number of failures	Share of failures with losses to depositors	Conditional loss rate	Unconditional loss rate
Panel A: Pre-FDIC				
1865-1913 (NB Era)	531	0.68	0.39	0.27
1914-1928 (Early Fed)	652	0.92	0.53	0.49
1929-1934 (Great Depression)	1710	0.82	0.40	0.32
All	2893	0.81	0.43	0.35
Panel B: Post-FDIC				
1992-2008	302	0.43	0.24	0.10
2008-2022	536	0.06	0.43	0.03
All	838	0.2	0.28	0.06

Notes: The loss rates reported in panel (A) are from the OCC's tables on national banks placed in receivership. The final loss rate for depositors does not account for interest payments or discounting. The data in panel (B) are as reported in FDIC (2023). The conditional loss rate is the loss rate for failures involving a loss for uninsured depositors.

Table B.5: ***Uninsured Depositor Loss Rates in Bank Failures by Cause of Failure***

Cause of Failure	Number of failures	Share of failures with losses to depositors	Conditional loss rate	Unconditional loss rate
Economic conditions	533	0.95	0.50	0.47
Excess. Lending	83	0.70	0.33	0.23
Fraud	330	0.76	0.42	0.32
Governance	226	0.94	0.47	0.44
Losses	344	0.68	0.47	0.32
Other	14	1.00	0.23	0.23
Run	28	0.64	0.46	0.30
Not classified	1335	0.79	0.38	0.30

Notes: The loss rates are from the OCC's tables on national banks placed in receivership for failures between 1863 and 1945. The final loss rate for depositors does not account for interest payments or discounting. The conditional loss rate is the loss rate for failures involving a loss for uninsured depositors.

Table B.6: ***Predicting Bank Failures: 1880-1904***

Horizon h	Fail in next year					3 years	5 years
Withdrawals before failure					>7.5%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Solvency:							
- Surplus/Equity	-0.98***		-0.32*	-0.19	-0.01	-0.94***	-1.12***
	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
- Dividend Payout Restricted	2.25***		0.99***	0.92***	0.80***	2.06***	2.44***
	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Funding:							
- Wholesale Funding/Assets		18.50***	30.47***	29.70***	16.16***	59.84***	80.44***
		(0.01)	(0.02)	(0.02)	(0.01)	(0.03)	(0.03)
Solvency × Funding:							
- Surplus/Equity × WF/Assets			-62.56***	-60.52***	-35.03***	-115.43***	-147.79***
			(0.05)	(0.05)	(0.04)	(0.08)	(0.10)
- Div. Restricted × WF/Assets			50.83***	51.44***	23.97***	49.70***	37.88***
			(0.03)	(0.03)	(0.02)	(0.04)	(0.06)
Bank Growth:							
- Q1 of Growth from t-3 to t				0.40***	0.20***	0.63***	0.56***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q2 of Growth from t-3 to t				0.13*	0.04	0.06	-0.08
				(0.00)	(0.00)	(0.00)	(0.00)
- Q4 of Growth from t-3 to t				0.12*	0.05	0.14	0.21
				(0.00)	(0.00)	(0.00)	(0.00)
- Q5 of Growth from t-3 to t				0.04	-0.05	0.32**	0.53***
				(0.00)	(0.00)	(0.00)	(0.00)
Aggregate Conditions:							
- GDP Growth from t-3 to t				-0.78***	-0.52***	-2.09***	-1.67***
				(0.00)	(0.00)	(0.00)	(0.00)
N	73576	73576	73576	73392	73392	73392	73392
No of Banks	5291	5291	5291	5254	5254	5254	5254
Mean of dep. var.	.41	.41	.41	.4	.19	1.1	1.7

Notes: This table presents OLS estimates of (2) with failure between t and $t+h$ as the dependent variables for the 1880-1904 sample. In addition to the reported predictor variables, we also include the log of a bank's age. Standard errors in parentheses are clustered at the bank level; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table B.7: ***Predicting Bank Failures: 1914-1928***

Horizon h	Fail in next year					3 years	5 years
Withdrawals before failure					>7.5%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Solvency:							
- Surplus/Equity	-4.07***		0.47	0.94***	0.31	0.01	-2.45***
	(0.00)		(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
- Loans/Assets	0.57***		-0.36***	-0.35***	-0.20**	-0.86***	-1.38***
	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Funding:							
- Time Deposits/Assets		1.04***	2.90***	3.07***	1.29***	8.05***	13.27***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
- WF/Assets		7.00***	11.39***	11.87***	5.09***	24.06***	26.36***
		(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Solvency $\times$ Funding:							
- Surplus/Equity $\times$ Time Dep./Assets			-5.29***	-5.38***	-2.24***	-13.08***	-19.72***
			(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
- Loans/Assets $\times$ Time Dep./Assets			1.12***	0.87**	0.50*	3.66***	8.30***
			(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
- Surplus/Equity $\times$ WF/Assets			-34.02***	-33.72***	-17.95***	-67.05***	-79.34***
			(0.01)	(0.01)	(0.01)	(0.03)	(0.04)
- Loans/Assets $\times$ WF/Assets			16.26***	15.74***	10.36***	37.07***	52.64***
			(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
Bank Growth:							
- Q1 of Growth from t-3 to t				1.20***	0.68***	3.09***	3.86***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q2 of Growth from t-3 to t				0.06	0.02	0.50***	0.64***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q4 of Growth from t-3 to t				-0.08	-0.03	-0.31*	-0.76***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q5 of Growth from t-3 to t				-0.16*	-0.10	-0.46***	-0.53**
				(0.00)	(0.00)	(0.00)	(0.00)
Aggregate Conditions:							
- GDP Growth from t-3 to t				-1.11***	-0.63***	-4.27***	-7.68***
				(0.00)	(0.00)	(0.00)	(0.00)
N	92254	92631	92254	91865	91865	91865	91865
No of Banks	9345	9345	9345	9324	9324	9324	9324
Mean of dep. var.	.64	.63	.64	.64	.34	2.5	5.6

Notes: This table presents OLS estimates of (2) with failure between t and $t+h$ as the dependent variables for the 1914-1928 sample. In addition to the reported predictor variables, we also include the log of a bank's age. In addition to the reported predictor variables, we also include the log of a bank's age. Standard errors in parentheses are clustered at the bank level; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table B.8: ***Predicting Bank Failures: 1929-1934***

Horizon h	Fail in next year					3 years	5 years
Withdrawals before failure					>7.5%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Solvency:							
- Equity/Assets	-9.42***		-10.63***	-14.21***	-7.68***	-42.79***	-53.46***
	(0.02)		(0.01)	(0.02)	(0.01)	(0.02)	(0.03)
- Surplus/Equity	-10.89***		-3.96***	-2.41***	-1.69***	-9.68***	-9.70***
	(0.01)		(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
- Dividend Payout Restricted	3.44***		2.14***	1.94***	0.97***	1.76***	0.87
	(0.00)		(0.00)	(0.00)	(0.00)	(0.01)	(0.01)
- Loans/Assets	12.24***		4.80***	4.11***	2.99***	14.79***	19.32***
	(0.01)		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Funding:							
- Wholesale Funding/Assets		97.52***	170.92***	170.31***	96.60***	245.50***	243.95***
		(0.02)	(0.04)	(0.04)	(0.03)	(0.07)	(0.08)
Solvency $\times$ ***Funding:***							
- Surplus/Equity $\times$ WF/Assets			-230.17***	-228.94***	-129.14***	-216.25***	-181.79***
			(0.10)	(0.10)	(0.08)	(0.17)	(0.18)
Bank Growth:							
- Q1 of Growth from t-3 to t				2.78***	1.85***	4.18***	4.36***
				(0.00)	(0.00)	(0.01)	(0.01)
- Q2 of Growth from t-3 to t				0.57*	0.38	1.58***	1.68***
				(0.00)	(0.00)	(0.00)	(0.01)
- Q4 of Growth from t-3 to t				-0.75**	-0.47*	-1.95***	-2.15***
				(0.00)	(0.00)	(0.00)	(0.01)
- Q5 of Growth from t-3 to t				-0.74**	-0.25	-1.72***	-2.29***
				(0.00)	(0.00)	(0.00)	(0.01)
Aggregate Conditions:							
- GDP Growth from t-3 to t				0.53	2.87***	14.70***	30.09***
				(0.01)	(0.00)	(0.01)	(0.01)
N	32795	32818	32777	32702	32702	32702	32702
No of Banks	7429	7428	7428	7419	7419	7419	7419
Mean of dep. var.	3.5	3.5	3.5	3.5	2.1	9.8	12

Notes: This table presents OLS estimates of (2) with failure between t and $t+h$ as the dependent variables for the 1929-1934 sample. In addition to the reported predictor variables, we also include the log of a bank's age. Standard errors in parentheses are clustered at the bank level; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table B.9: ***Predicting Bank Failures: 1959-2023***

Horizon h	Fail in next year					3 years	5 years
Withdrawals before failure					>7.5%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Solvency:							
- Net Income/Assets	-53.03***		12.03***	12.63***	1.05***	19.89***	20.92***
	(0.00)		(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Funding:							
- Time Deposits/Deposits		2.18***	4.36***	4.40***	0.56***	10.41***	13.14***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Solvency × Funding:							
- NI/Assets × TD/Dep.			-354.33***	-356.87***	-47.78***	-674.32***	-719.49***
			(0.02)	(0.02)	(0.01)	(0.03)	(0.04)
Bank Growth:							
- Q1 of Growth from t-3 to t				0.07***	-0.01	0.27***	0.44***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q2 of Growth from t-3 to t				-0.06***	-0.00	-0.15***	-0.18***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q4 of Growth from t-3 to t				0.03*	0.01	0.15***	0.29***
				(0.00)	(0.00)	(0.00)	(0.00)
- Q5 of Growth from t-3 to t				0.02	0.01	0.54***	1.32***
				(0.00)	(0.00)	(0.00)	(0.00)
Aggregate Conditions:							
- GDP Growth from t-3 to t				-0.06	0.57***	0.24*	2.04***
				(0.00)	(0.00)	(0.00)	(0.00)
N	616046	614680	614680	604764	209731	604764	604764
No of Banks	22155	22152	22152	22127	14432	22127	22127
Mean of dep. var.	.26	.26	.26	.27	.035	.88	1.4

Notes: This table presents OLS estimates of (2) with failure between t and $t+h$ as the dependent variables for the 1959-2023 sample. In addition to the reported predictor variables, we also include the log of a bank's age. The sample in column (5) is restricted to the years from 1993-2023 due to unavailability to deposits in failure before 1993. Standard errors in parentheses are clustered at the bank level; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table B.10: ***Predictability of Failures By Era and During Major Banking Crises***

Panel A: 1865-1935						
	1890	1893	1890-1896	1930-1933	1929-1931	1932-1933
AUC	0.876	0.830	0.810	0.793	0.796	0.864
Panel B: 1959-2023						
	1959-1981	1982-1994	1994-2006	2007-2023	1984-1990	2007-2013
AUC	0.887	0.945	0.866	0.952	0.943	0.949

Notes: This table reports the area under the receiver operating characteristic curve (AUC) by sample period. In the first three columns of Panel A, we use in-sample predictions based on the estimation using data from 1889 through 1904 that corresponds to column (4) of Table B.6. In the last three columns of panel A, we use in-sample predictions based on the estimation using data from 1929-1935 in column (4) of Table B.8. In Panel B, we calculate the AUC based on the predictions obtained from the model in column (4) of Table B.9.

Table B.11: ***Net Asset Growth in Failing Banks Before and After the FDIC***

Era	Average	Share of failures with asset growth falling within...					
		<-30%	[-30%,-20%]	[-20%,-7.5%]	[-7.5%,-2.5%]	[-2.5%,0%]	>0
Panel A: Pre versus Post-FDIC							
1880-1934 (Pre-FDIC)	-19.15	0.18	0.22	0.40	0.10	0.03	0.07
1993-2023 (Post-FDIC)	0.66	0.01	0.01	0.08	0.12	0.21	0.57
Panel B: By Era							
1880-1913 (NB Era)	-21.56	0.28	0.23	0.30	0.07	0.02	0.09
1914-1918 (Early Fed)	-20.15	0.19	0.21	0.43	0.10	0.02	0.06
1929-1933 (Depr., pre-Hld.)	-23.35	0.20	0.28	0.42	0.07	0.01	0.02
1933-1934 (Depr., post-Hld.)	-3.29	0.01	0.06	0.40	0.22	0.10	0.22
1993-2006	-1.06	0.03	0.02	0.19	0.09	0.37	0.28
2007-2023	1.00	0.00	0.00	0.06	0.13	0.18	0.62

Notes: This table reports the percent change between nominal asssts in the last call report before failure and the assets reported in failure. Before 1935, assets in failure are as reported in the OCC annual reports table on national banks in receivership. This records assets "at date of suspension." After 1935, we use assets as reported in the FDIC's list of failing banks.

Table B.12: ***Fundamentals Predict Aggregate Rate of Bank Failures: Robustness to Model Selection***

Dependent variable	Aggregate Failure Rate			
	(1)	(2)	(3)	(4)
Predicted failure rate, $\overline{p}_{t\|t-1}$	2.82***	2.68***	1.72***	1.06***
	(0.87)	(0.28)	(0.29)	(0.10)
Constant	-0.18	-0.12*	-0.11	0.09**
	(0.17)	(0.06)	(0.08)	(0.04)
N	102	102	102	100
R^2	.35	.64	.61	.72
Table 2 model	(1)	(2)	(3)	(4)
Sample	Full	Full	Full	Full

Notes: This table presents time series regressions of the annual aggregate failure rate in year t on the predicted aggregate failure rate $\overline{p}_t$. The predicted aggregate failure rate in each column is based on the model from that column in Table 2. The time series model is estimated on the full sample. Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

C Data Appendix

C.1 Appendix B1: Call Reports

OCC Annual Report to Congress: 1863 through 1941 We use two main data sources on bank balance sheets. Data on national bank balance sheets from 1863 through 1941 are from the Office of the Comptroller of the Currency's (OCC) Annual Report to Congress.

Note that the format of the tables changes in 1905. Starting in 1905, balance sheets for multiple banks are reported in tables that go across two pages. Figure C.2 shows an example of the format after 1905 form the annual report to congress of 1933. We digitze these data also using the techniques discussed in Correia and Luck (2023).

Figure C.1: *Example of a Balance Sheet Reported in the OCC's Annual Report to Congress from 1900.*

338 REPORT OF THE COMPTROLLER OF THE CURRENCY.

KENTUCKY.

Farmers' National Bank, Augusta.

JOHN M. HARBESON, *President.* No. 4612. BEN HARBESON, *Cashier.*

Resources.		Liabilities.	
Loans and discounts	$113,507.83	Capital stock paid in	$50,000.00
Overdrafts	1,251.06	Surplus fund	4,450.00
U. S. bonds to secure circulation	16,250.00	Undivided profits, less current expenses and taxes paid	2,249.16
U. S. bonds to secure deposits	....	National-bank notes outstanding	16,250.00
U. S. bonds on hand	100.00	State-bank notes outstanding	....
Premiums on U. S. bonds	15.00	Due to other national banks	1,126.08
Stocks, securities, etc	22,625.00	Due to State banks and bankers	258.93
Bank'g house, furniture, and fixtures	1,000.00	Due to trust companies and savings banks	....
Other real estate and mortg's owned	1,800.00	Due to approved reserve agents	....
Due from other national banks	11,444.74	Dividends unpaid	....
Due from State banks and bankers	....	Individual deposits	260,480.44
Due from approved reserve agents	142,627.00	United States deposits	....
Internal-revenue stamps	356.32	Deposits of U.S. disbursing officers	....
Checks and other cash items	43.25	Notes and bills rediscounted	....
Exchanges for clearing house	....	Bills payable	....
Bills of other national banks	6,490.00	Liabilities other than those above stated	1,100.75
Fractional currency, nickels, cents	33.66		
Specie	9,059.00		
Legal-tender notes	8,500.00		
U. S. certificates of deposit	....		
Redemption fund with Treas. U. S.	812.50		
Due from Treasurer U. S.	....		
Total	335,915.36	Total	335,915.36

Figure C.2: *Example of a Balance Sheet Reported in the OCC's Annual Report to Congress from 1933.*

Assets and liabilities of national banks as shown by reports of condition December 30, 1933—Continued

ILLINOIS—Continued

DISTRICT NO. 8—Continued

	Location and name of bank	President	Cashier	Loans and discounts, including overdrafts	United States Government securities owned	Other bonds, stocks, and securities, etc., owned
1	National City, National Stock Yards.	O. J. Sullivan	R. D. Garvin	$3, 664, 806	$6, 532, 834	$733, 004
2	New Douglas, Prange	A. F. Prange	W. W. Prange	107, 457	50, 000	64, 219
3	Oblong, First	S. F. Odell	J. B. McKnight	786, 318	83, 500	208, 704
4	O'Fallon, First	E. H. Smiley	W. R. Dorris	296, 662	174, 207	484, 832
5	Okawville, First	W. G. Frank	W. E. Friend	151, 758	79, 547	307, 394
6	Okawville, Old Exchange	C. H. Merrick	F. Moehle	88, 300	76, 675	216, 049
7	Pittsfield, First	L. C. King	F. A. Hicks	650, 876	251, 425	166, 315
8	Ramsey, Ramsey	L. C. Thiele	J. E. Easterday	137, 655	51, 250	43, 077
9	Raymond, First	J. E. McDavid	C. McNaughton	431, 989	35, 588	116, 659
10	Robinson, Second	A. U. McCandless	A. H. Lodge	1, 190, 820	485, 556	327, 905
11	St. Francisville, Peoples	S. Gray	G. H. Corrie	170, 068	107, 500	110, 128
12	Salem, Salem	J. C. Martin	A. H. Bachman	353, 021	968, 786	1, 324, 844
13	Sandoval, First	B. F. Holmes	H. H. Bellamy	58, 831	45, 710	28, 768
14	Smithton, First	J. A. Miller	E. P. Baltz	113, 288	59, 881	80, 845
15	Sorento, National	L. C. Dreiling	H. H. Holbrook	10, 902		9, 491
16	Sparta, First	T. B. Stephenson	P. G. Brown	168, 354	95, 550	53, 236
17	Staunton, Staunton	C. F. Hackman	J. W. P. Kerr	85, 469	82, 293	237, 000
18	Sumner, First	G. W. Hill	O. D. Atkins	38, 933	59, 787	148, 707
19	Vandalia, First	F. L. Rice	R. H. Sturgess	234, 469	428, 738	170, 332
20	Vienna, First	W. L. Williams	F. E. Worrell	213, 432	100, 181	33, 951
21	Waterloo, First	N. B. Pautler	J. F. Schmidt	172, 706	223, 338	136, 773
22	Wayne City, First	J. F. Mateer	W. O. Allen	88, 400	52, 700	33, 908
23	White Hall, White Hall	C. A. Ruckel	R. S. Worcester	371, 118	206, 063	188, 280
24	Witt, Security	H. F. Fesser	H. S. Armentrout	121, 245	64, 346	138, 243
25	Woodlawn, First	E. A. Hill	M. Wood	68, 828	47, 522	44, 461
26	Wood River, First	O. F. Nagel	G. G. Guker	237, 024	92, 269	170, 906
27	Wood River, Wood River	J. M. Olin	H. E. Paton	261, 407		55, 577
28	Worden, First	T. C. Unger	W. E. Meyer	38, 797	33, 308	10, 941
29	Xenia, First	J. M. Tully	E. Kepp	99, 489	34, 000	1, 169
30	Zeigler, First	F. G. Hitt	R. R. Frazier	49, 690	390, 574	220, 202

Cash and exchange including reserve with Federal Reserve bank	Other assets	Total assets	Capital	Surplus	Undivided profits	Total deposits	Circulation	Bills payable and rediscounts	Other liabilities	
$3, 678, 840	$123, 007	$14, 732, 491	$750, 000	$150, 000	$45, 440	$12,983,612	$750, 000		$53, 439	1
16, 019	4, 386	242, 081	25, 000	10, 000	837	206, 244				2
210, 440	76, 380	1, 365, 342	75, 000	50, 000	21, 563	1, 144, 859	73, 860		60	3
183, 751	75, 195	1, 214, 647	100, 000	30, 000	4, 676	979, 939	100, 000		32	4
44, 503	5, 173	588, 375	50, 000	10, 000	7, 526	470, 830	50, 000		19	5
67, 929	4, 889	453, 842	50, 000	10, 000	14, 951	328, 891	50, 000			6
206, 835	113, 931	1, 389, 352	125, 000	125, 000	41, 325	998, 602	99, 280		175	7
68, 692	14, 762	315, 436	25, 000	25, 000	7, 675	232, 761	25, 000			8
34, 659	41, 646	660, 541	50, 000	10, 000	763	494, 282	25, 000	$80, 496		9
432, 586	67, 348	2, 504, 215	150, 000	37, 500	33, 989	2, 188, 976	93, 750			10
34, 200	19, 456	441, 352	70, 000	10, 000	5, 723	305, 624	50, 000		5	11
360, 591	71, 420	3, 078, 662	100, 000	24, 000	56, 830	2, 822, 645	75, 000		187	12
49, 091	24, 437	206, 837	40, 000	2, 500	1, 301	138, 354	24, 640		42	13
25, 757	16, 668	296, 439	25, 000	8, 000	350	238, 032	25, 000		57	14
30, 302	5, 532	56, 227	25, 000	1, 850	(d) 7, 631	33, 982		3, 000	26	15
178, 157	30, 215	525, 512	50, 000	25, 000	11, 078	389, 401	50, 000		33	16
64, 862	15, 841	485, 465	50, 000	10, 000	26, 387	349, 032	50, 000		46	17
81, 973	8, 685	338, 085	25, 000	5, 000	674	281, 707	25, 000		704	18
202, 209	68, 789	1, 104, 597	100, 000	25, 000	19, 309	860, 078	100, 000		150	19
57, 696	59, 123	464, 383	60, 000	25, 000	2, 812	317, 130	59, 340		101	20
100, 669	6, 336	639, 872	25, 000	15, 000	1, 437	573, 435	25, 000			21
35, 121	33, 126	243, 255	45, 000		1, 436	171, 768	25, 000		51	22
121, 473	16, 158	903, 112	100, 000	20, 000	29, 480	703, 632	50, 000			23
27, 591	7, 947	350, 372	25, 000	5, 000	5, 248	209, 124	25, 000			24
95, 669	9, 520	266, 000	35, 000	2, 000	3, 282	200, 718	25, 000			25
123, 661	50, 285	674, 145	50, 000	50, 000	2, 571	521, 416	50, 000		158	26
129, 894	69, 034	515, 912	60, 000	30, 000	10, 786	415, 126				27
18, 348	11, 710	113, 104	25, 000	5, 000	194	57, 912	24, 998			28
52, 560	14, 866	202, 084	25, 000		1, 082	150, 963	25, 000		39	29
116, 201	46, 553	829, 220	35, 000	7, 000	23, 940	729, 280	34, 000			30

C.1.1 FFIEC 010 and FFIEC 013: 1959 through 2023

For the modern, contemporary banking system, we use the Federal Financial Institutions Examination Council (FFIEC) Consolidated Reports of Condition and Income ("Call Report"). These data provide quarterly information on balance sheets (FFIEC010) and income statements (FFFIEC013) on a consolidated basis for all commercial banks operating in the United States and regulated by the FRS, the FDIC, and the OCC. Figure C.3 shows an example of the balance sheet reporting form used in 1967. Figure C.4 shows an example of the income statement reporting form of the same year.

We document the construction of our variables from the various line items in table Table C.1.

Table C.1: ***Definitions of FFIEC 010 and 013 line items.***

Item	Series	Item Number	Valid Period
Assets	RCON	2170	1959–12–31 to present
Equity	RCON	3210	1959–12–31 to present
Deposits	RCON	2200	1959–12–31 to present
Loans	RCON	1400	1959–12–31 to present
		2122	1976–03–31 to present
Cash	RCON	0010	1959–12–31 to present
Securities	RCON	0400 + 0600 + 0900 + 0950	1959–06–10 to 1976–03–31
		0390	1976–03–31 to 1993–12–31
		1754 + 1773	1994–03–31 to present
C&I loans	RCON	1600	1959–12–31 to 1984–03–31
		1766	1984–03–31 to present
Real Estate Loans	RCON	1410	1959–12–31 to present
Consumer Loans	RCON	1975	1959–12–31 to present
Credit Card Loans	RCON	2008	1967–12–31 to 2000–12–31
		B538	2001–03–31 to present
Financial Loans	RCON	1495	1959–06–10 to 1983–12–31
		1505 + 1510 + 1517 + 1756 +1757	1976–03–31 to 2000–12–31
		B531 + B534 + B535	2001–03–31 to present
Time Deposits	RCON	2514	1961–04–12 to 1983–12–31
	RCON	2604 + 6648	1984–03–31 to 2009–12–31
	RCON	J473 + J474 + 6648	2010–03–31 to present
Demand Deposits	RCON	2210	1959–12–31 to present
Brokered Deposits	RCON	2365	1983–09–30 to present
Insured Deposits	RCON	2702	1983–06–30 to 2006–03–31
	RCON	F045 + F049	2006–06–30 to present
Uninsured Deposits	RCON	2710 - (2722*100)	1983–06–30 to 1992–12–31
	RCON	5597	1993–03–31 to present
Loan Loss Provisions	RIAD	4230	1969–12–31 to present
Net Income	IADX	5106	1960–12–31 to 1968–12–31
	RIAD	4340	1969–12–31 to present
Non-Performing Loans	RCON	1403 + 1407	1982–12–31 to present
Total Interest Income	RIAD	4107	1984–03–31 to present
Total Interest Expenses	RIAD	4170 + 4180 + 4190 + 4200	1969–12–31 to 1978–09–30
	RIAD	4170 + 4180 + 4185 + 4200	1978–12–31 to 1983–12–31
	RIAD	4073	1984–03–31 to present
Salaries and Employee Benefits	RIAD	4135	1969–12–31 to present
Number of Full-Time Employees	RIAD	4150	1969–12–31 to present

Figure C.3: *Example of FFIEC 010 Reporting Form from 1967.*

Form F.R. 105 — Call 186 (Rev. 12-67) December 30, 1967 - December 31, 1968 — RCRI / RCON

Budget Bureau No. 55-R004

Please read carefully "Instructions for the Preparation of Report of Condition"—Every item and schedule must be filled in. Printed items must not be amended. Amounts that cannot properly be included in the printed items must be entered under "Other assets" or "Other liabilities."

DIST-ST-BANK 9000

Report of Condition of 9010 (Legal title of bank)

of 9130 (City), ______ (County), ______ (State) (Zip Code), **at the close of business on** 9999, **19** ..

State Bank No. 9020 — *Federal Reserve District No.* 9170

Item		Dollars	Cts.	
ASSETS				
1. Cash, balances with other banks, and cash items in process of collection (Schedule D, item 7)		0010		1
2. United States Government obligations		0400		2
3. Obligations of States and political subdivisions		0900		3
4. Securities of Federal agencies and corporations		0600		4
5. Other securities (including $...... corporate stocks)		0950		5
6. Federal funds sold and securities purchased under agreements to resell		1350		6
7. Other loans and discounts (Schedule A, item 10)		1400		7
8. Bank premises, furniture and fixtures, and other assets representing bank premises		2145		8
9. Real estate owned other than bank premises		2150		9
10. Customers' liability to this bank on acceptances outstanding	2153	2155		10
11. Other assets (item 6 of "Other assets" schedule)		2160		11
12. TOTAL ASSETS		2170		12
LIABILITIES				
13. Demand deposits of individuals, partnerships, and corporations (Schedule E, item 4)	2615	2220		13
14. Time and savings deposits of individuals, partnerships, and corporations (Schedule F, item 6)		2360		14
15. Deposits of United States Government (Schedule E, item 5 and Schedule F, item 7)		2610		15
16. Deposits of States and political subdivisions (Schedule E, item 6 and Schedule F, item 8)		2620		16
17. Deposits of foreign governments and official institutions, central banks and international institutions (Schedule E, item 7 and Schedule F, item 9)	2645	2650		17
18. Deposits of commercial banks (Schedule E, items 8 and 9 and Schedule F, items 10 and 11)		2660		18
19. Certified and officers' checks, etc. (Schedule E, item 10)		2330		19
20. TOTAL DEPOSITS (items 13 to 19)	$ 2200	xxx xxx	xxx xx	20
(a) Total demand deposits (Schedule E, item 11)	$ 2210	xxx xxx	xxx xx	(a)
(b) Total time and savings deposits (Schedule F, item 12)	$ 2350	xxx xxx	xxx xx	(b)
21. Federal funds purchased and securities sold under agreements to repurchase		2800		21
22. Other liabilities for borrowed money		2850		22
23. Acceptances executed by or for account of this bank and outstanding	2915	2920		23
24. Other liabilities (item 7 of "Other liabilities" schedule) (including $...... mortgages and other liens on bank premises and other real estate)		2930		24
25. TOTAL LIABILITIES		2950		25
CAPITAL ACCOUNTS				
26. (a) Capital notes and debentures		3200		26 (a)
(b) Preferred stock—total par value (No. shares outstanding ______)		3220		(b)
(c) Common stock—total par value (No. shares authorized ______) (No. shares outstanding ______)	3210	3230		(c)
27. Surplus		3240		27
28. Undivided profits		3250	3247	28
29. Reserve for contingencies and other capital reserves		3260		29
30. TOTAL CAPITAL ACCOUNTS		3270		30
31. TOTAL LIABILITIES AND CAPITAL ACCOUNTS		3300		31

Figure C.4: *Example of FFIEC 013 Reporting Form from 1967.*

December 31, 1978 - December 31, 1982

Consolidated Report of Income of ______________________________ RCRI / RIAD

Legal Title of Bank

For period ending on ______________________________, 19___

Section A - Sources and Disposition of Income

Dollar Amount in Thousands		Year-to-date Mil Thou	
1. OPERATING INCOME:			
a. Interest and fees on loans		4010	1.a.
b. Interest on balances with depository institutions		4115	1.b.
c. Income on Federal funds sold and securities purchased under agreements to resell in domestic offices of the bank and of its Edge and Agreement subsidiaries		4020	1.c.
d. Interest on U.S. Treasury securities	4027	4030	1.d.
e. Interest on obligations of other U.S. Government agencies and corporations		4040	1.e.
f. Interest on obligations of States and political subdivisions in the U.S.		4050	1.f.
g. Interest on other bonds, notes, and debentures	4060	4061	1.g.
h. Dividends on stock		4063	1.h.
i. Income from lease financing		4065	1.i.
j. Income from fiduciary activities		4070	1.j.
k. Service charges on deposit accounts in domestic offices		4080	1.k.
l. Other service charges, commissions, and fees		4090	1.l.
m. Other operating income (from Section D, item 4)		4100	1.m.
n. TOTAL OPERATING INCOME (sum of items 1a thru 1m)		4000	1.n.
2. OPERATING EXPENSES:			
a. Salaries and employee benefits		4135	2.a.
b. Interest on time certificates of deposit of $100,000 or more issued by domestic offices		4174	2.b.
c. Interest on deposits in foreign offices	4170	4172	2.c.
d. Interest on other deposits		4176	2.d.
e. Expense of Federal funds purchased and securities sold under agreements to repurchase in domestic offices of the bank and of its Edge and Agreement subsidiaries		4180	2.e.
f. (1) Interest on demand notes (note balances) issued to the U.S. Treasury	4185	4195	2.f.(1)
(2) Interest on other borrowed money		4190	2.f.(2)
g. Interest on subordinated notes and debentures		4200	2.g.
h. (1) Occupancy expense of bank premises, Gross	4210		2.h.(1)
(2) Less: Rental income	4215		2.h.(2)
(3) Occupancy expense of bank premises, Net	4217	4205	2.h.(3)
i. Furniture and equipment expense		4220	2.i.
j. Provision for possible loan losses (from Section C, item 4)		4230	2.j.
k. Other operating expenses (from Section E, item 3)		4240	2.k.
l. TOTAL OPERATING EXPENSES (sum of items 2a thru 2k)		4130	2.l.
3. INCOME BEFORE INCOME TAXES AND SECURITIES GAINS OR LOSSES (item 1n minus 2l)		4250	3.
4. APPLICABLE INCOME TAXES		4260	4.
5. INCOME BEFORE SECURITIES GAINS OR LOSSES (item 3 minus 4)		4270	5.
6. a. SECURITIES GAINS (losses), GROSS	4280		6.a.
b. APPLICABLE INCOME TAXES	4285		6.b.
c. SECURITIES GAINS (losses), NET		4290	6.c.
7. NET INCOME (item 5 plus or minus 6c)		4300	7.
OR			
7. INCOME BEFORE EXTRAORDINARY ITEMS		4300	7.
8. EXTRAORDINARY ITEMS, NET OF TAX EFFECT (From Section F, item 2c)		4320	8.
9. NET INCOME (item 7 plus or minus 8)		4340	9.

4025

C.2 Data on National Bank Receiverships

We digitize an extensive set of tables with information on national banks in charge of receivers from the OCC's Annual Report to Congress from each year between 1920 to 1939. The 1920 OCC Annual Report contains information on all receiverships from the first receivership in 1865 until receiverships initiated in August 1920. We further digitize the tables on receiverships for each year from 1921 to 1939 to record information on receiverships initiated after 1920, as well as receiverships initiated before 1920 but terminated after 1920.

These data contain a range of information, including the date the receiver was appointed; the date the bank was finally closed; deposits at suspension; assets at suspension; an estimate of the breakdown of assets at suspension by good, doubtful, or worthless assets; additional assets received after the date of suspension; total collections from assets; total collections from shareholder assessments; dividends paid to claim holders; and legal expenses. The data on deposits outstanding at the time of suspension are available starting in 1880. These tables also contain the OCC's assessment of the cause of failure.

From this information, we calculate the recovery rate on assets as the amount collected from assets divided by the sum of assets at suspension and assets received after suspension. For the depositor recovery rate, we use the dividends paid (in %), reported by the the OCC. This reflects the dividends paid relative to the amount of claims proved. The depositor recovery rate does not include interest or account for the time value of money. Figure B.3 shows that the depositor recovery in the first year amounts to only about half of the final recovery.

Causes of Failures as Classified By the OCC From 1863 to 1928, the OCC classified the "apparent cause of failure" for almost all bank failures. For 1929, 1930, and 1931, the OCC classified the cause of failure for 78%, 75%, and 48% of failures, respectively. The OCC did not classify the cause of failure for failures occurring in 1932 and 1933. However, we were able to obtain the cause of failure for 12 failures from 1934-1937 from the OCC's 1937 Annual Report to Congress. See Figure C.5 for the share of failures not classified by year.

We group the detailed cause of failure classifications from the OCC into one of the following broad categories:

- **Excessive lending:** Excessive lending refers to a bank lending more than 10% of its paid-in capital to a single counterparty, which was not permitted by the national banking act.

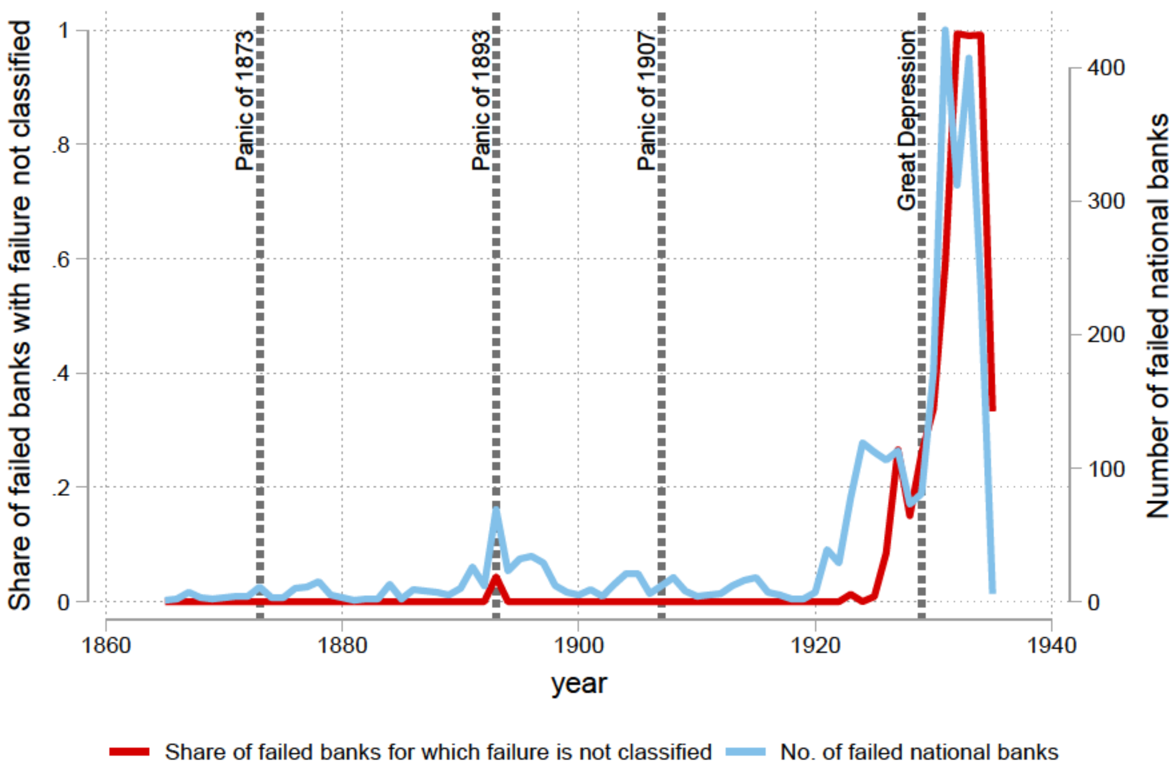
- **Economic conditions:** We classify failure as caused by external economic factors whenever the OCC cited the trigger of failure being related to things outside of a banks control such as crop losses, a deterioration of local economic conditions, robbery, or other shocks.

- **Fraud:** We classify a failure as due to fraud when the OCC cited misbehavior from bankers as the cause of failure. Fraud can be related to dishonesty of a bank employee or owner and excessive loans to insiders.

- **Governance:** We classify a failure being due to governance issues if bad management practices are cited as the cause of failure
- **Losses:** We refer to the cause of failure being due to losses when the bank is subject to losses or unable to realize on assets, injudicious banking practices, or depleted reserves.
- **Run:** We classify a run as being the cause of failure when the OCC reports the bank was closed by a run or anticipation of a run or heavy withdrawals.

Table C.2 shows the detailed mappings.

Figure C.5: *Classification of causes of failure by the OCC across time.*



Notes: This figure shows the share of failed national banks for which the OCC did not provide a cause of failure (left y-axis) and the number of failed national banks (right y-axis) from 1863 through 1935.

Table C.2: ***OCC Causes of Failure Classification*.**

OCC Cause of Failure	*Simplified Label*
Crop loss and depreciation of securities	Economic conditions
Crop loss	Economic conditions
Deflation	Economic conditions
Local financial conditions	Economic conditions
Local financial depression from unforeseen agricultural or industrial disaster	Economic conditions
Excessive loans and failure of large debtors	Excessive lending
Excessive loans to officers and directors	Excessive lending
Excessive loans to others and depreciation of securities	Excessive lending
Excessive loans to others and investments in real estate and mortgages	Excessive lending
Excessive loans to others, injudicious banking, and depreciation of securities	Excessive lending
Excessive loans	Excessive lending
Failure of large debtors	Excessive lending
Defalcation by cashier	Fraud
Defalcation by former cashier	Fraud
Defalcation of officers and depreciation of securities	Fraud
Defalcation of officers and excessive loans to others	Fraud
Defalcation of officers and fraudulent management	Fraud
Defalcation of officers	Fraud
Dishonesty of an officier of employee and local financial depression from unforeseen agricultural or industrial disaster	Fraud
Dishonesty of an officier of employee	Fraud
Dishonesty	Fraud
Excessive loans to officers and directors and depreciation of securities	Fraud
Excessive loans to officers and directors and investments in real estate and mortgages	Fraud
Forgeries and embezzlement	Fraud
Fraudulent management	Fraud
Fraudulent management and closed by run	Fraud
Fraudulent management and depreciation of securities	Fraud
Fraudulent management and injudicious banking	Fraud
Fraudulent management and local financial conditions	Fraud
Fraudulent management, defalcation of officers, and depreciation of securities	Fraud
Fraudulent management, excessive loans to officers and directors, and depreciation of securities	Fraud
Fraudulent management, excessive loans to officers and directors, and excessive loans to others	Fraud
Fraudulent management, injudicious banking, investments in real estate and mortgages, and depreciation of securities	Fraud
Fraudulent management	Fraud

Irregularities of president and speculation in real estate	Fraud
Irregularities	Fraud
Wrecked by assistant cashier	Fraud
Wrecked by cashier and president and by excessive loans to themselves	Fraud
Wrecked by defalcation by bookkeeper	Fraud
Wrecked by president	Fraud
Wrecked by the cashier	Fraud
Bad management	Governance
Incompetent management and dishonesty of an officier of employee	Governance
Incompetent management and local financial depression from unforeseen agricultural or industrial disaster	Governance
Incompetent management	Governance
Bad paper taken over from old organization	Losses
Bad paper	Losses
Deficient reserve and unable to realize on loans	Losses
Depleted reserve	Losses
Depleted reserve and shrinkage of deposits	Losses
Depreciation of securities	Losses
Formerly in voluntary liquidation	Losses
General stringency of the money market, shrinkage in values, and imprudent methods of banking	Losses
Injudicious banking and adverse business conditions	Losses
Injudicious banking and depreciation of securities	Losses
Injudicious banking and excessive loans to officers and others	Losses
Injudicious banking and failure of large debtors	Losses
Injudicious banking	Losses
Insufficient credit	Losses
Investment in real estate mortgages and depreciation of securities	Losses
Investments in real estate and mortgages and depreciation of securities	Losses
Large losses and defalcation	Losses
Large losses and injudicious banking	Losses
Large losses in loans and discounts	Losses
Large losses, withdrawals, and insufficient credit	Losses
Large losses	Losses
Receiver appointed after sale of assets, and stockholders to vote to place bank in liquidation	Losses
Receiver appointed after voluntary liquidation	Losses
Receiver appointed to assess stockholders	Losses
Receiver appointed to levy and collect stock assessment covering deficiency in value of assets sold, or to complete unfinished liquidation	Losses
Receiver appointed to levy and collect stock assessment covering deficiency in value of assets sold	Losses
Unable to realize on assets	Losses
Unable to realize on loans and failure of stockholders to pay balance due on capital	Losses

Unable to realize on loans	Losses
Information not available	No information
Robbery and burning of bank	Other
Temporary suspension	Other
Temporary suspension to adjust settlement on adverse judgment	Other
Closed by directors in anticipation of run	Run
Closed by run	Run
Directors closed due to rumor of run	Run
Heavy withdrawals and lack of public confidence	Run
Heavy withdrawals	Run
Inability to meet demands	Run
Large demands and depleted cash	Run
Local financial conditions and closed by run	Run