NBER WORKING PAPER SERIES

WHO CAN TELL WHICH BANKS WILL FAIL?

Kristian Blickle
Markus K. Brunnermeier
Stephan Luck

Working Paper 29753
http://www.nber.org/papers/w29753

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 2022, Revised May 2025

A draft of this paper was formerly circulated as "Micro-evidence from a System-wide Financial Meltdown: The German Crisis of 1931." Special thanks to our discussants Matthew Baron, Sebastian Doerr, Michael Faulkender, Caroline Fohlin, Matthieu Gomez, Victoria Ivashina, Rajkamal Iyer, Yiming Ma, Jose Luis Peydro, and Ellis Tallman. We also thank Anat Admati, Mark Aguiar, Charles Calomiris, Mark Carlson, Ing-Haw Cheng, Natalie Cox, Thomas Eisenbach, A draft of this paper was formerly circulated as "Micro-evidence from a System-wide Financial Meltdown: The German Crisis of 1931." Special thanks to Manju Puri (editor), two anonymous referees, and our discussants Matthew Baron, Sebastian Doerr, Michael Faulkender, Caroline Fohlin, Matthieu Gomez, Victoria Ivashina, Rajkamal Iyer, Yiming Ma, Jose Luis Peydro, and Ellis Tallman. We also thank Anat Admati, Mark Aguiar, Charles Calomiris, Mark Carlson, Ing-Haw Cheng, Natalie Cox, Thomas Eisenbach, Douglas Diamond, Darrell Duffie, Jakub Kastl, David Lucca, Martin Hellwig, Kilian Huber, Jonathan Payne, Matt Plosser, Paul Schempp, Chris Sims, David Thesmar, Emil Verner, Eugene White, Carolyn Wilkins as well as seminar participants at Princeton University, Harvard Business School, the Federal Reserve Bank of New York, 2020 AEA San Diego, DIW Berlin, IFO Munich, MoFiR Banking workshop, 2020 NBER CF, 2021 AFA Chicago, 2021 SED meetings, and the 2019 NBER SI DAE for useful comments. We further would like to thank Natalia Fischl-Lanzoni, Alena Kang-Landsberg, Harry Cooperman, and Elaine Yao for excellent research assistance. We thank Francis Mahoney and employees of the Bundesarchiv in Berlin for great help on the archival work. Financial support from Princeton University, the Bendheim Center for Finance, Lars Peter Hansen and the Macro Financial Modeling (MFM) project is greatly appreciated. The replication code and data are available in the Harvard Dataverse at https://doi.org/10.7910/DVN/XLCPY7. The opinions expressed in this paper are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of New York, the Federal Reserve System, or the National Bureau of Economic Research.

At least one co-author has disclosed additional relationships of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w29753

Who Can Tell Which Banks Will Fail?
Kristian Blickle, Markus K. Brunnermeier, and Stephan Luck
NBER Working Paper No. 29753
February 2022, Revised May 2025
JEL No. G20, G21

ABSTRACT

We study the run on the German banking system in 1931 to understand whether depositors anticipate which banks will fail in a major financial crisis. We find that deposits decline by around 20% during the run. There is an equal outflow of retail and non-financial wholesale deposits from both failing and surviving banks. In contrast, we find that interbank deposits decline almost exclusively for failing banks. Our evidence suggests that banks are better informed about which fellow banks will fail. In turn, banks being informed allows the interbank market to continue providing liquidity even during times of severe financial distress.

Kristian Blickle
Federal Reserve Bank of New York
kristian.blickle@ny.frb.org

Stephan Luck
Federal Reserve Bank of New York
stephan.luck@ny.frb.org

Markus K. Brunnermeier
Princeton University
Department of Economics
and CEPR
and also NBER
markus@princeton.edu

1 Introduction

In this paper, we study the run on the German banking system in the spring of 1931 and ask: in light of a major financial shock, can depositors tell which banks will fail? Are banks better than regular depositors in anticipating which banks are more likely to fail? And, to the extent that banks can tell which other banks will fail, are they willing to provide liquidity to otherwise healthy banks via the interbank market?

Understanding depositor behavior and interbank market dynamics during bank runs is important for designing optimal policy measures to prevent or contain banking crises. Empirical studies of bank runs have made great progress in understanding depositor behavior during runs on individual institutions (Iyer and Puri, 2012; Iyer et al., 2016; Martin et al., 2022). Still, to study whether depositors differentiate between weaker and stronger banks in their withdrawal behavior, it is desirable to observe depositor behavior across heterogeneous banks during the same macroeconomic shock. Likewise, the ability of the interbank market to provide liquidity is best tested during a major financial shock, when the entire banking system is stressed. However, the empirical analysis of system-wide bank runs is typically constrained as government interventions distort depositor withdrawal decisions (Iyer et al., 2019) and make system-wide runs infrequent in modern times (Baron et al., 2020).

In this paper, we use newly digitized historical micro-level data to study the run on the German banking system from May through July 1931—one of the largest bank runs in economic history and a key event of the Great Depression (Kindleberger, 1973; James, 1984). There are three key advantages in studying this historical episode. First, the German system was lightly regulated with no capital or liquidity requirements and no deposit insurance. Thus, all types of depositors could plausibly expect to realize losses in the case of a bank failure. Second, we can obtain and digitize granular and comprehensive bank balance sheets at a monthly frequency, allowing us to study run dynamics in more detail than previous work. Third, the system-wide nature of the bank run provides an empirical laboratory with a large number of failing banks—15 out of around 120 banks in our sample failed during the crisis—exposed to the same macroeconomic environment. Taken together, this allows us to establish whether and which depositors anticipate which banks will fail.

Our findings are simple but striking. We find that deposits decline by around 20% over the two months from the start of the run to the end, when the government declared a bank holiday. There is no difference in total deposit outflows between failing and surviving banks. This implies that, *on average*, depositors seem unable to successfully identify which banks will fail. However, the average obscures the distinct behaviors of different types of depositors. We find that outflows of regular deposits—retail and non-financial wholesale deposits—are the same across failing and surviving banks. In contrast, interbank deposits decline mostly for failing banks. Banks themselves withdraw almost exclusively from banks that end up failing but not from banks that end up surviving. Thus, failing banks start to lose access to the interbank market throughout the run and by the end of the run, they are essentially shut out of the interbank market. This pattern, in turn, implies that interbank deposit flows during the run can be used to predict which banks will fail. The area under the receiver operating characteristic curve (AUC), a common measure of diagnostic performance for a binary classifier, can exceed 80% using a simple regression model in which failure is predicted by interbank deposit flows.

We further study interbank dynamics during the run in more detail. We show that in normal times—before the run—banks subject to deposit outflows respond by borrowing from banks subject to deposit inflows, exactly as predicted by theories of optimal risk-sharing via interbank markets (Allen and Gale, 2000). While aggregate deposit funding of the banking system contracts during the run, we document that there is also substantial heterogeneity in deposit flows across banks and some banks obtain deposit inflows. Notably, we find that banks that experience deposit inflows do not hoard liquid funds as suggested by theories of interbank market freezes (Caballero and Krishnamurthy, 2008; Allen et al., 2009). In contrast, they continue to intermediate funds to banks that are subject to deposit outflows. However, only surviving, not failing, banks subject to deposit outflows are able to borrow from other banks. Thus, while the interbank market collapses for failing banks, it remains functioning for surviving banks even in times of severe financial distress.

There are at least two plausible and not mutually exclusive explanations for our main findings. Either banks are well informed about which banks will fail and withdraw from failing banks to protect themselves. Or, alternatively, it could be the case that failing banks fail because they are losing access to interbank funding. While both explanations are a priori reasonable, we argue that the former explanation is more plausible than the latter for the following two reasons. First, we find that total deposit funding (both regular and interbank deposit funding) contracts by about the same percentage share for failing and surviving banks. This equal outflow of total funding is possible despite the striking differences in interbank deposits flows because interbank deposits represent on average only a small share of total deposit funding. Theories of bank runs and fire sales, however, imply that the primary determinant of whether a bank becomes illiquid first and then insolvent is the *total* shortfall of funding (Diamond and

Dybvig, 1983; Goldstein and Pauzner, 2005) rather than the *composition* of funding. Consequently, the scope for the shortfall of interbank funding alone to cause failure is reduced. Second, we show that our findings are unchanged when restricting our sample to banks that rely very little on interbank funding to begin with and for which interbank deposit outflows cannot plausibly be the immediate cause of failure. Altogether, we argue that losing access to funding from other banks alone is unlikely to have caused the failure, similar to findings by Perignon et al. (2018).

It is important to highlight that our empirical approach does not allow us to determine between the causes of bank failures more generally. In particular, we cannot distinguish whether withdrawals are primarily caused by the prospect of fundamental insolvency (as in a solvency run) or whether overall withdrawals are the primary cause of default (as in a panic-based run).[1] Our approach instead focuses on the information structure: which depositors understand which banks will ultimately fail? The differential response between regular and interbank deposits allows us to conclude that domestic banks are well informed about which banks will fail due to the crisis, while regular deposit flows are uninformative about failure. However, we cannot identify *what* information banks are acting on. Our findings allow for different possibilities. Banks may have information about a specific bank's solvency that is independent of deposit withdrawals. Or, banks may have information about which banks are more likely to be perceived as fragile by regular depositors and fail as a consequence of their withdrawals.

We also provide a set of additional important empirical findings that support the interpretation that banks are well-informed and able to tell which banks will fail. First, we show that interbank funding declines more at banks that relied on foreign-currency-denominated deposits. In light of concerns about Germany's ability to maintain the Gold Standard (see, e.g., Ferguson and Temin, 2003), the incentives to withdraw foreign-currency-denominated deposits during the run were likely to be stronger than for regular deposits. Importantly, whether a bank had such an exposure to this more risky type of funding was not public information but only reported in confidential filings at the Reichsbank. Thus, given that we find that interbank funding declines more at banks that relied on foreign-currency-denominated deposits reinforces the idea that bank had a good sense of which banks were at risk during the run.

Second, we study the extent to which the stock market identifies failing banks for a small subset of

[1] Following the terminology of Diamond and Dybvig (1983) and Goldstein and Pauzner (2005), we refer to a *panic-based run* as a run in which a bank had survived under the counterfactual in which the depositors don't withdraw but failed because withdrawals happened. In a solvency run, in contrast, the bank would have been insolvent irrespective of withdrawal decisions.

our original sample. We find that the stock prices of failing banks start to decline in the first month of the run and fall by around 25% more than those of surviving banks over the course of the crisis. These stock returns can be predicted by interbank flows in the early phase of the run.

Finally, we document that failing banks are at times subject to demand deposit *inflows* during the run, but these inflows are mirrored by *outflows* of time deposits. Thus, depositors are more likely to take a cautious stance in failing banks and convert deposits with longer maturity into those that can be withdrawn easily, indicative of maturity shortening (Brunnermeier and Oehmke, 2013). This pattern of outflows of time deposits rather than demand deposits also confirms the finding by Martin et al. (2022) that flows of term deposits in failing banks tend to be more sensitive to bank risk than demandable transaction deposits.

Our findings have important policy implications. Our conclusion that banks are well-informed about which banks will fail suggests that the interbank market can be effective in providing liquidity to otherwise financially sound banks even in the midst of large financial shocks. Thus, our findings support the view that the interbank market can be surprisingly resilient (Afonso et al., 2011). Further, the existence of a functioning interbank market can be valuable beyond standard risk-sharing rationales. Central bank actions that make interbank markets redundant—such as an abundant reserves regime—should consider the cost of losing the valuable information contained in the interbank market and the potential to provide discipline through interbank flows.

Our findings also lend support to the view that banking crises are not just sudden and unpredictable events. Existing research shows that crises typically follow credit booms (Schularick and Taylor, 2012; Baron et al., 2020) and whether a crisis will happen can thus in part be predicted (Greenwood et al., 2022). We find that interbank deposit growth—unlike total deposit funding growth—contains information that allows us to predict which banks will fail. Given that banks themselves seem to know "where the bodies are buried", our findings suggests that, conditional on being in a banking crisis, it is possible to predict which banks are more likely to fail.

Taken together, our evidence also provides an empirical reconciliation between the two standard rationales for the existence of short-term debt. On the one hand, short-term debt can be a means to provide valuable liquidity services to depositors (Diamond and Dybvig, 1983; Gorton and Pennachi, 1990). On the other hand, it can also be an instrument that allows depositors to discipline bank behavior (Calomiris and Kahn, 1991; Diamond and Rajan, 2000, 2001). The two types of rationales differ considerably in how they view depositors and may thus be in conflict (Admati and Hellwig, 2013): while the former regards them as liquidity demanders, the latter considers them to be informed providers of discipline. While we do not test either theory directly, our finding that different types of depositors vary widely in how informed they are offers a resolution: interbank depositors get rewarded for being informed and attentive by withdrawing first from failing banks—comparable to the informed depositors in the model from Calomiris and Kahn (1991)—and are thus able to discipline other banks. Regular deposit flows, in contrast, are not informative about failure. Hence, regular depositors may not be well positioned to provide discipline but rather value liquidity benefits associated with holding deposits.

Our analysis proceeds as follows. First, we review the theoretical and empirical bank run literature in Section 2. We then provide a description of our data and background about the German banking system in 1931 in Section 3. Next, we provide a comprehensive empirical description of the dynamics of the German Crisis and system-wide run of 1931 in Section 4. Using granular balance sheet data for a large set of banks as well as the central bank, we study what types of depositors withdraw first and how banks meet withdrawals. Our main analysis is presented in Section 5 where we study the cross-sectional variation in bank deposit flows and bank failures, investigate whether failing banks are more likely to lose deposits, and whether bank failure can be predicted by deposit flows. We study the dynamics in the interbank market in more detail in Section 6 and present additional findings in Section 7. Section 8 concludes.

2 Literature

Our paper contributes to a rich literature on bank runs and banking crises. Seminal work by Diamond and Dybvig (1983) shows under which conditions demand deposit contracts can insure depositors against idiosyncratic liquidity risk, but also how demand deposit contracts set the stage for coordination failures and self-fulfilling runs.[2] A complementary rationale for the existence of short-term funding of

[2]There are a large number of theoretical studies of the subject, which can broadly be categorized into three generations of models. The first generation of bank run models explains bank runs as a consequence of coordination failures as in Diamond and Dybvig (1983)

The second generation of models shows under which conditions models of self-fulfilling bank runs have a unique equilibrium. Morris and Shin (1998), Rochet and Vives (2004) and Goldstein and Pauzner (2005) suggest setups in which the common knowledge assumption is relaxed, allowing for a unique threshold equilibrium to exist in which all agents withdraw from a bank when the aggregate return of the bank's assets falls short of a cutoff. Importantly, there exists a range of states of the world in which the bank is fundamentally solvent but nonetheless experiences a run. These types of runs are then referred to as panic-based runs.

Further, a third generation of bank run models provide theories of dynamic bank runs. He and Xiong (2012) show that dynamic coordination games, in which rollover decisions are based on anticipated future rollover decisions by other debtholders, can exhibit unique threshold equilibria without the common knowledge assumption being violated. He and Manela (2016) discuss the interaction of agents incentives to acquire information and the dynamics of a bank run. Their analysis shows that depositors' incentives to acquire information increase the longer the run continues.

banks and bank runs is provided by Calomiris and Kahn (1991) and Diamond and Rajan (2000, 2001), who argue that demand deposit contracts are an instrument to discipline the behavior of the bank's management. In this line of argument, bank runs are equilibrium outcomes as a response to information about non-diligent behavior of bankers as well as the aggregate state of the economy.[3]

While the theoretical literature on system-wide bank runs has made great progress, the empirical study of the subject is often constrained by the lack of adequate settings and data. Either governments intervene before a system-wide bank run fully plays out (Baron et al., 2020), or, when it does occur, data are only available at a low frequency. Thus, existing empirical work either focuses on bank runs in settings in which deposit insurance or related government interventions affect depositors' incentives (Iyer et al., 2019), or the analysis is concerned with banking crises from prior to or during the Great Depression, when data are typically not available at a high frequency. The key advantage of our setting is that our granular monthly data allow us to analyze depositors' behavior—including interbank depositors—during a major financial shock in a setting in which depositors of all types had to expect to realize losses if their bank failed.

Evidence on the importance on the heterogeneity of depositor behavior during bank runs in contemporary settings is provided by Iyer and Puri (2012) and Iyer et al. (2016), Martin et al. (2022), Artavanis et al. (2022) and Iyer et al. (2019). Iyer and Puri (2012) establish that depositors that have stronger ties to the banks, either socially or financially, are less likely to withdraw. Iyer et al. (2016) provide evidence that sophisticated and uninsured depositors are more sensitive to solvency risk. Martin et al. (2022) emphasize the importance of gross funding inflows in troubled banks and show that, prior to bank failure, outflows of uninsured deposits are offset with inflows of insured deposits. Moreover, they establish that time deposits tend to be less "sticky" than demand deposits, possibly reflecting depositor sophistication and the forward-looking nature of term deposits. Artavanis et al. (2022) use deposit-level to study the case of a slow run on a Greek bank in 2015. All the above settings, while providing valuable information about depositor behaviour, focus on runs on individual institutions. Our paper complements these important papers by studying the behavior of depositors in a lightly regulated banking system that featured a system-wide run.[4]

[3] Eisenbach (2017) provides a model in which short-term debt is disciplining, but withdrawals also induce fire sales, implying that the disciplining effect is too weak in boom periods but too strong in downturns. Yet another alternative rationale for short-term debt is provided by Brunnermeier and Oehmke (2013) who argue that maturity of debt may have a tendency to be excessively short when intermediaries cannot commit to the overall maturity structure of their debt.

[4] See also Goldstein (2013) for an overview of empirical evidence on bank runs. Further, there are several detailed accounts of run-like phenomena in specific market segments during the 2007-09 financial crisis (see Brunnermeier, 2009, for an overview). Gorton (2012) and Copeland et al. (2014) focus on the collapse in bilateral and tri-party repo during the crisis, respectively.

By studying the dynamics in the interbank market in a system-wide run, our work also directly relates to empirical studies of interbank market dynamics. Iyer and Peydró (2011) test financial contagion due to interbank linkages and Iyer et al. (2014) study the real effects of interbank market distress. Similarly, Craig and Ma (2022) study systemic risk in the contemporary German interbank market. Afonso et al. (2011) study the interbank market in the U.S. during the 2007-09 financial crisis. Like Afonso et al. (2011) we find evidence that the interbank market continues to function during a major financial shock. Banks do not hoard liquidity but only stop lending to failing banks. Surviving banks continue to be able to borrow. Our findings are also in line with evidence from Perignon et al. (2018), who study wholesale funding dry-ups for European banks around the European Debt Crisis and stress the role of informed and uninformed investors.

Other papers that have studied system-wide banking panics in lightly regulated banking systems are largely confined to historical episodes in which data are available at a much lower frequency or aggregate rather than bank-level data. In classic studies, Gorton (1988) and Calomiris and Gorton (1991) show that system-wide banking panics during the National Banking Era typically occurred when economic activity peaked. Calomiris and Mason (1997) also provides an account of the bank failures in Chicago during 1932 and supports the view that weaker banks were more likely to fail. Saunders and Wilson (1996) and Calomiris and Mason (2003b) study causes of bank failures during the Great Depression using biannual data and find evidence that the causes of the bank runs were related to fundamental solvency concerns. Calomiris and Mason (2003a) study the real effects associated with the Great Depression and Frydman et al. (2015) study the real effects of the Panic of 1907. Kelly and Ó Gráda (2000) and Ó Gráda and White (2003) study depositor runs using depositor-level data in a case study of a New York bank during the Panics of 1854 and 1857. The closest to our work is the paper by Ó Gráda and White (2003) who find that less sophisticated depositors withdrew during the non-systemic run of 1854, but more educated depositors were withdrawing their deposits during the system-wide crisis of 1857. However, their study is confined to studying a single bank while we can study the entire banking system, including the interbank dynamics.

Covitz et al. (2013) and Krishnamurthy et al. (2014) focus on the run on ABCP in the summer of 2007 and Acharya et al. (2013) on the implications for commercial banks that had sponsored off-balance-sheet ABCP conduits. Kacperczyk and Schnabl (2013) and Schmidt et al. (2016) study the pre-crisis behavior of and the runs on money market mutual funds, in particular subsequent to the failure of Lehman Brothers. Foley-Fisher et al. (2020) study the run on U.S. life insurers during the summer of 2007. Moreover, further evidence from the 2007-2009 financial crisis is provided by Ivashina and Scharfstein (2010), who show that, next to runs by short-term debt holders, firms draw on credit lines, increasing the liquidity needs of banks during times of financial fragility. This type of phenomena is also discussed in Acharya and Mora (2015) and Ippolito et al. (2016) and for the COVID pandemic by Chodorow-Reich et al. (2022). The advantage of our setting over these papers is that we can study a run that concerns the entire banking system and not just specific market segments.

An important exception in the empirical bank run literature is the paper by Schumacher (2000), which studies the cross-sectional variation in bank stability during a banking panic that took place in Argentina in 1995 following the Mexican "Tequila shock." Importantly, Argentina at the time had no deposit insurance scheme and no wider safety net. However, the crucial advantage of our empirical approach is that we have information on the different types of deposit flows and thus the richness of our data allows us to test for heterogeneity in depositor information explicitly.

Another important exception is Mitchener and Richardson (2019) who use weekly city-level data to show how interbank market crashes amplified the credit crunch during the Great Depression. Besides the fact that our paper allows to provide bank-level as opposed to city-level evidence at a relatively high frequency, note that the German banking system in the 1930s featured geographically diversified banks. The U.S. banking system before and during the Great Depression, in contrast, featured mostly local banking markets and thus a hierarchical interbanking system, with very different roles for country banks and reserve city banks. Thus, in contrast to Mitchener and Richardson (2019), our study provides evidence from a setting without deposit insurance in which the overall structure of the banking system is more similar to that of contemporary banking systems than the historical U.S. banking system is. In contrast to Mitchener and Richardson (2019), we find that the interbank market need not necessarily be a source of financial contagion during times of distress but can provide liquidity.

Further, our paper also relates to a set of papers that evaluate the role of deposit insurance on market discipline across various empirical settings. For instance, Anderson et al. (2023) study the effect of the creation of the Federal Deposit Insurance Corporation (FDIC) and find that while deposit insurance reduced monitoring, it did not entirely eliminate it. Calomiris and Jaremski (2019) show that the introduction of deposit insurance schemes in U.S. states during the early 20th century removed market discipline. Karas et al. (2013) study the effects of deposit insurance in Russia during the 1990s and also find declines in market discipline. Peria and Schmukler (2001) study the cases of Argentina, Chile, and Mexico during the 1980s and 1990s and find that depositors discipline banks by withdrawing deposits and by requiring higher interest rates but only limited effects of deposit insurance on market discipline. Our paper, by utilizing a unique historical setting and novel data, complements these papers by providing additional evidence that banks themselves are the most informed depositors and thus best positioned to provide discipline. However, it is important to highlight that while our paper provides some insights on how depositors can behave in absence of deposit insurance, unlike the papers mentioned above, it does not allow to test the effectiveness of depositor discipline itself and cannot directly speak to the issue of moral hazard stemming from deposit insurance.

Finally, our paper also contributes to the literature on the Great Depression in Germany. Papers studying the more general role of the economic and political crisis and the rise of political extremism and the Nazi party are provided by Galofré-Vilà et al. (2021) and Doerr et al. (2022), with the latter focusing on the impact of the failure of the Danatbank—the second largest bank at the time and discussed in more detail below—on the rise of fascism. Two important accounts of the crisis episode, interpreting it primarily as a banking crisis, are provided by Born (1967) and James (1984). In contrast, Temin (1971, 2008) and Ferguson and Temin (2003) put more emphasis on the actions of the German government. Kindleberger (1973) and Eichengreen (1995) emphasize the international dimensions of both, currency and banking crisis. Schnabel (2004) emphasized the role of "too big to fail" guarantees for the large Berlin banks that may have led to excessive risk-taking. Moreover, Schnabel (2009) also studies the effect of liquidity and government guarantees on bank stability during the crisis.

3 Data and Setting

Our main data source is a set of detailed monthly bank balance sheets that were collected by the central bank—henceforth "Reichsbank"—and made publicly available via the contemporary newspaper *Deutscher Staats- und Preussischer Reichsanzeiger*. Digital versions of the newspaper are made available by the University of Mannheim (Kling, 2016) and complemented by hand-collected data from the archives of the Reichsbank held at the Federal German Archives ("Bundesarchiv") in Berlin and Koblenz.[5]

Bank balance sheets for large commercial banks are available monthly between 1928 and 1933, excluding balance sheets as of December and January. Banks that report their balance sheets to the Reichsbank include the very largest banks with a nation-wide branch network—so called "Berlin banks"—as well as the smaller regional credit banks with a local or no branch network. Further, our sample also includes clearing banks and brokers for savings banks ("Girozentralen") and publicly-owned banks ("Landesbanken").

Note that our data do not include information on local savings banks, mortgage banks, or private investment banks and brokers. Altogether, our data cover an average of more than 120 banks per month which constitute more than 50% of the entire German banking sector's assets (Schnabel, 2004) and more

[5]All Reichsbank data are available in the federal archives in Berlin and can be seen for specific research purposes with special dispensation from the archives. For the data described above, see, for instance, Reichsbank archival data: R 2501 "Deutsche Reichsbank": 6479, 6480, 6482, 6484, 6491-2, 6559, 6634, 6709, 6746, 7712.

than 75% of total C&I lending. Importantly, the banks in the parts of the banking system for which no micro data are available are not offering the exact same services and have slightly different business models. For instance, local savings banks were largely financed by retail depositors and invested in mortgages or intermediated funds to the Landesbanken and Girozentralen (which are part of our sample). Private banks tended to be investment banks or brokers. The Berlin banks and regional credit banks raised deposit funding from both retail *and* wholesale depositors. Note that the sample selection implies that the banks in our sample are likely to be financed by depositors that are more sophisticated and larger than the average depositor.

The data are fairly granular with more than 70 balance-sheet items reported. Among other things, the data distinguish between domestic interbank and regular deposits, demand and time deposits, loans and covered bonds, as well as high- and low-quality liquid assets.[6] Table 1 gives an overview of the observable characteristics in our sample. The table reports the average of assets (Panel A) and liability (Panel B) items as a share of total assets and liabilities for 126 banks that report balance sheets between February and April 1931. We report the respective shares as averages for the entire banking sector as well as for the four different types of banks mentioned above. In the columns far left of Panel A, we also report the average bank size and number of banks in each category.[7]

The largest banks in our sample are the 6 Berlin banks (of which 4 had nation-wide branch systems) with an average balance-sheet size of around 2 billion Reichsmarks (RM). In contrast, regional credit banks are much smaller, with an average balance-sheet size of only 50 million RM. Girozentralen are considerably larger than the regional banks but also smaller than the Berlin banks, with an average asset balance of 300 and 240 million RM, respectively.

[6] Appendix A.6 in the Appendix provides an example of a reported balance sheet. Subsets of the data have been used before, e.g. by James (1984), Ferguson and Temin (2003), Schnabel (2004, 2009), Adalet (2009) and Collet and Postel-Vinay (2021).

[7] Note that we report the distribution of some of the core characteristics in Figure A.15 in the Appendix.

Table 1: ***Bank Assets and Liabilities by Share of Total Assets in Spring 1931*.**

Panel A: Assets

Bank Type	Illiquid Assets			Liquid Assets					Assets (in mil. RM)	No. of Banks
							Interbank			
		Loans	Covered Bonds		High	Low	Total	Short-term		
All Banks	0.73	0.52	0.15	0.15	0.05	0.10	0.09	0.04	214	126
Berlin Banks	0.64	0.60	0.00	0.21	0.06	0.15	0.14	0.07	2,088	6
Girozentralen	0.74	0.21	0.49	0.08	0.06	0.02	0.17	0.03	300	17
Regional Banks	0.74	0.63	0.03	0.16	0.04	0.12	0.07	0.04	52	82
Landesbanken	0.75	0.32	0.39	0.12	0.07	0.06	0.11	0.03	241	21

Panel B: Liabilities

Bank Type	Deposits							Acceptances	Bonds	Equity
		Demand	Time	Regular	Domestic Bank	Other	Foreign			
All Banks	0.66	0.22	0.40	0.51	0.23	0.03	0.10	0.03	0.14	0.17
Berlin Banks	0.86	0.27	0.42	0.60	0.11	0.17	0.77	0.05	0.01	0.07
Girozentralen	0.49	0.20	0.29	0.17	0.69	0.00	0.00	0.02	0.44	0.05
Regional Banks	0.70	0.23	0.44	0.61	0.10	0.03	0.07	0.03	0.03	0.23
Landesbanken	0.56	0.19	0.36	0.36	0.39	0.01	0.10	0.02	0.38	0.05

Notes: This table reports key balance sheet figures as a share of total assets. These shares are computed at the bank-level as averages for February through April 1931. Loans comprise credit lines to non-financial firms ("*Debitoren in Laufender Rechnung*"), lombard credit ("*Lombard und Reports*"), and trade credit ("*Vorschuesse auf verfrachtete oder eingelagerte Waren*"). Covered bonds consist of mortgage- and municipal bonds ("*Langfristige Ausleihungen gegen hypothekarische Sicherungen oder gegen Kommunaldeckung*"). The remaining illiqud assets consist of equity investments in other companies and financial firms ("*Konsortialbeteiligungen*") as well as the bank building, other property and other assets. High quality liquid assets are the sum of cash ("*Kasse*"), reserves ("*Guthaben bei Notenbanken*"), short-term government bonds ("*unverzinsliche Schatzanweisugen*"), and securities that qualify for being discounted at the Reichsbank ("*bei der Reichsbank beleihbare Wertpapiere*"). Low quality liquid assets are bills of exchange net of government bonds ("*Schecks und Wechsel*").

For liabilities, we distinguish between domestic interbank deposits ("*Deutsche Banken, Bankfirmen, Sparkassen, und sonstige deutsche Kreditinstitute*") and regular deposits ("*Sonstige Kreditoren* "). Demand deposits are the sum of all regular and domestic interbank deposits with no specified maturity or a specified maturity of less than 7 days. Time deposits are all regular and domestic interbank deposits with a maturity of more than 7 days. There is no information on the maturity of other deposits ("*Seitens der Kundschaft bei Dritten benutzte Kredite*"). Foreign deposits are estimated by multiplying the share of foreign deposits as of either July 1930 or July 1929 (depending on when available) with total deposits. Further, the tables report acceptances ("*Akzepte*") which is a type of bill of exchange and other liabilities, bonds ("*Langfristige Anleihen bzw. Darehen*"), and equity as the sum of capital paid in and reserves ("*Aktienkapital*" and "*Reserven*").

Source: Deutscher Reichs und Preussicher Staatsanzeiger from February 1931 through April 1931. Foreign Deposit data are constructed from confidential filings with the Reichsbank as described in the main text.

The average bank in our sample has around 73% of its funds invested in illiquid assets. Illiquid assets, in turn consist of 53% commercial and industrial loans and 15% covered bonds such as mortgages and municipal bonds.[8] Around 26% of banks' funds are invested in liquid assets. Liquid assets can broadly be categorized into liquid assets of higher and lower quality as well as interbank claims. High-quality liquid assets consist of cash, reserves, or government bonds. Lower-quality liquid assets are bills of exchange from private non-financial firms. Around 5% of assets are in high quality liquid assets and around 12% in low quality, and 9% in interbank claims. Note that for interbank claims, we can also distinguish between those due within seven days. On average around 45% of interbank claims are short-term.[9]

On the liability side, we can distinguish between different types of deposits. The balance sheet splits deposits into three different categories: deposits from domestic banks, regular deposits (which combines retail and non-financial wholesale deposits—including those denominated in foreign currency) and other types. Further, the reporting form distinguishes between those deposits that are due within seven days (which we refer to as demand deposits) and those with a specified maturity of more than seven days (which we refer to as time deposits). Note that the distinction by maturity is only applied for the sum of domestic interbank deposits and regular deposits. That is, we cannot distinguish by maturity within domestic interbank and regular deposits. Given that interbank claims have to be equal to interbank deposits in the aggregate, it's fair to assume that a little less than half of interbank deposits are due within seven days. Interbank lending was typically unsecured.

On average, banks finance 66% of their assets with deposits of which the majority are regular deposits: 51% of assets are financed by regular deposits and only 12% by domestic interbank deposits. Further, one can observe that equity finance is relatively higher at the smaller regional banks (23%), since these banks are not diversified geographically. In contrast, equity finance is lowest at the Berlin banks and Landesbanken (7% and 5%, respectively).

Note that there is considerable variation across the different types of banks, with Girozentralen and Landesbanken having a different business model than the large Berlin banks and the smaller regional banks. Berlin banks and regional banks were largely in the business of financing non-financial firms, in part by discounting their trade credit claims. In contrast, Girozentralen and Landesbanken intermediated investments from local savings banks, investing in mortgages and municipal bonds.

[8] Additional illiquid assets consist of equity investments, the bank's buildings, and other property.

[9] This contrasts with the contemporary German interbank market for which, from 2005-2009, the bulk of interbank loans was longer term (see Craig and Ma, 2022).

Hence, interbank deposits are much more common at the Girozentralen and the Landesbanken.[10] The main focus of our analysis is on regional banks and Berlin banks, which resemble a textbook banking business model of financing loans with deposits. All cross-sectional and panel estimations thus include bank-type or bank-type-time fixed effects, respectively. Further, throughout our analysis we also show that all main findings are not bank-type dependent and hold when using a sample of only the smaller regional banks.

Further, we also obtain data that was confidentially filed with the Reichsbank—and thus not publicly available during the run—and allow us to approximate the use of deposits denominated in foreign currencies. Information on the exposure to deposits denominated in foreign currency is crucial as many observers stress the role of deposits denominated in foreign currency in the run (see, e.g., Schnabel, 2004; Temin, 2008).[11] The information on the use of foreign-currency-denominated deposits available to us is limited to the summers of 1929 and 1930. We use it as a proxy for which banks issue foreign deposits and make foreign investments. Specifically, we approximate foreign-currency-denominated deposits by multiplying the maximum share of those deposits observed between 1929 and 1930 with the amount of overall deposits net of domestic interbank deposits. Table 1 shows that deposits denominated in foreign currency are highly concentrated in the large Berlin banks and a few of the larger regional banks. Foreign funding is essentially non-existent in the smaller regional banks and uncommon for Girozentralen and Landesbanken.

We also use the Reichsbank records as well as information from Born (1967) and Schnabel (2009) to determine which banks fail, which are merged, and which are actively bailed out by the state, see Table A.1 in the Appendix. We identify 15 banks that fail, and another 7 banks that did not fail but were distressed and received some form of government aid or were subjected to a distressed merger. We focus on contrasting deposit flows in failing versus surviving banks but also show that our results are robust to using a more general version of distressed banks.

We supplement the balance sheet data of banks with additional data sources. We hand-collect data on daily stock prices for the banks that were traded from the *Monatskursblatt*, published by the *Berliner Börsenpapiere* for 1931. These are monthly publications that contain daily stock- and bond-price

[10] Reflecting the differences between the bank business models, Berlin banks and regional banks also have a somewhat stronger reliance on deposit financing (86% and 70%, respectively), and Girozentralen and Landesbanken rely more on bond financing (44% and 38%, respectively). On average around 1/3 of regular and interbank deposits are short-term and 2/3 are time deposits.

[11] Note that James (1984) emphasizes that while deposits were foreign denominated, they were mostly held by Germans who had transferred funds to the Netherlands and Switzerland.

information for stocks traded on the Berlin Stock Exchange. It tracks closing trading prices for each day of the month. Not all the banks in our sample are publicly traded or listed on the Berlin exchange. We are able to match daily stock prices with balance sheet information from 28 banks covered in the *Reichsanzeiger*. We also hand-collect the weekly balance sheets of the Reichsbank for the entire year of 1931. The balance sheet includes information on the amount of notes outstanding as well as the amount of gold held by the Reichsbank in its vaults which we use in Appendix A.3 in the Appendix to provide more background on the Reichsbank's actions. We also follow Doerr et al. (2022) and measure firm-bank relationships based on information on the banks that paid out a firm's dividends (*Zahlstellen*). This information is reported in the investor manual *Saling's Börsen-Jahrbuch* and allow to proxy for whether a bank was connected to the non-financial firm "Nordwolle" which failed just before the height of the crisis and is closely related to the failure of Danatbank.

A key advantage in studying the German Crisis of 1931 is that the bank run took place in a banking system that had very little government interventions. Specifically, there was no capital or liquidity regulation and most importantly no deposit insurance. The German banking system was following a German tradition of "self-regulation" in which the only interventions came from the Reichsbank with its only real power stemming from the ability to refuse to act as a lender of last resort (James, 1984).[12] Given our research objective, it is important to establish that depositors—regular depositors and interbank depositors alike—had a reason to believe that they would realize losses on their deposits in case of a bank failure. Thus, in Appendix A.1, we provide evidence that bank failures were quite common before the run in 1931 and in those bank failures, depositors typically realized losses. Thus, depositors of any type had reasons to expect that they would realize losses if their respective bank failed.

4 The German Crisis of 1931

In this section, we first provide a brief discussion of the key events of the crisis and then discuss how the run presents itself in our data. Note that we keep the description of the historical events to a minimum and provide a more detailed description of the crisis and its circumstances in Appendix A.2 and refer to existing work that provides detailed narratives of the crisis (Born, 1967; James, 1984; Schnabel, 2004).

The run on the German banking system in 1931 was preceded by a two-year period of contraction in output and employment, deflation, and a high degree of political uncertainty. The run on the German

[12] More details on the behavior of the Reichsbank are provided in Appendix A.3 in the Appendix.

banking system can be broadly categorized into three phases from early May 1931 through July 1931. In the first phase in May 1931, the interbank market shows signs of distress. The distress started when the failure of the largest Austrian bank, the "Creditanstalt", was announced on May 11, 1931 (Born, 1967; Kindleberger, 1973; James, 1984). German banks were not contractually linked to the Creditanstalt. Although bank failures were quite common in interwar Germany, as discussed in Appendix A.1, the failure of the Creditanstalt was remarkable. It was the largest Austrian bank and its failure was widely unanticipated by the public. Thus, the failure of the Creditanstalt is sometimes interpreted as a "*Minsky* moment" that triggered a banking crisis without revealing any additional information about the state of the German banking system (James, 1984).

The second phase of the run coincides with the German government's announcement on June 6 that it was unwilling/unable to continue reparations payments, thus raising doubts about Germany's ability to maintain the Gold Standard. During this second phase in June and early July, withdrawals continued with varying intensity. For instance, withdrawals picked up when a major creditor of Danatbank called "Nordwolle" announced heavy losses, leading to speculation about Danatbank's imminent failure. Similarly, withdrawals started to slow down noticeably after the announcement of the "Hoover moratorium" on June 19, a suggestion by U.S. President Herbert Hoover to pause all war-related debt payments for one year. However, when French opposition to the arrangement became clear throughout the end of June, withdrawals intensified again.

The third and final phase of the crisis was reached on July 10-13 when the Reichsbank's gold reserves had fallen below the legally mandated 40% gold-to-notes coverage ratio. In anticipation, the Reichsbank had started a last attempt to obtain emergency loans from the Bank of England and the Banque de France.[13] When this attempt was unsuccessful, the Reichsbank decided to further increase the discount rate and tighten its already restricted liquidity provision to the banks. This rendered the Danatbank illiquid, as it had already discounted all of the assets that qualified for Reichsbank purchases. As an additional last-minute attempt to merge Danatbank and Deutsche Bank failed, Danatbank had announced it would not open its branches again on Monday, July 13.

Following the failure of Danatbank, retail depositors started a full-blown panic, queuing at most banks to withdraw their funds. This triggered the illiquidity of "Dresdner Bank", at the time the third largest bank, on July 14. The then full-blown run led the government to intervene by imposing a

[13]In a dramatic turn the Reichsbank's president Hans Luther travelled by air—quite uncommon at the time—to both London and Paris, requesting an emergency loan (Luther, 1968). Both turned Luther's requests down.

two-day bank holiday, which was followed by an effective suspension of convertibility lasting throughout August[14] and the introduction of capital controls. Further, the government ensured that illiquid banks would have access to the liquidity provision of the Reichsbank and set up a conduit that allowed banks to make their securities eligible for Reichsbank purchases. While deposits continued to contract until the end of 1931, albeit at a slower pace, the financial crisis was over when the government restructured the largest banks in spring 1932.[15]

How does the run present itself in the data? Figure 1 depicts the aggregate flows of a selected set of bank assets and liabilities relative to the previous month. The shaded areas depict month-to-month flows in assets, while the colored lines depict flows in liabilities. Aggregate deposits contract by around 500mil RM from April to May. From May to June as well as from June to July, the aggregate deposit outflow almost triples, to a little less than 1,500mil RM per month, representing an outflow of around 8% of the pre-crisis level of total deposits for two consecutive months. Overall, deposits fall by around 5bn RM between March and November 1931, around 25% of the pre-crisis level.[16]

Figure 1 reveals that during the first month of the bank run—in the immediate aftermath of the failure of the Creditanstalt—the deposit outflow is largely accounted for by a contraction in domestic interbank deposits, which is accompanied by an equal fall in interbank claims.[17] The first month of the run is therefore largely a run of banks on banks. Moreover, interbank lending and borrowing continue to contract steadily throughout the crisis.

Between May and July, deposit outflows intensify. In addition to the contraction of interbank deposits in May, more than 1bn RM of regular deposits such as retail and non-financial wholesale deposits are withdrawn from the banking system in both June and July. Banks meet these withdrawals largely by reducing their holdings of liquid securities (red shaded area), discounting them at the Reichsbank as discussed in more detail in Appendix A.3. Illiquid assets such as loans and mortgages are also contracting (blue shaded area) but contract much more slowly than the securities portfolio during the bank run itself.

To obtain the dynamics for more detailed categories of assets and liabilities, we estimate the following

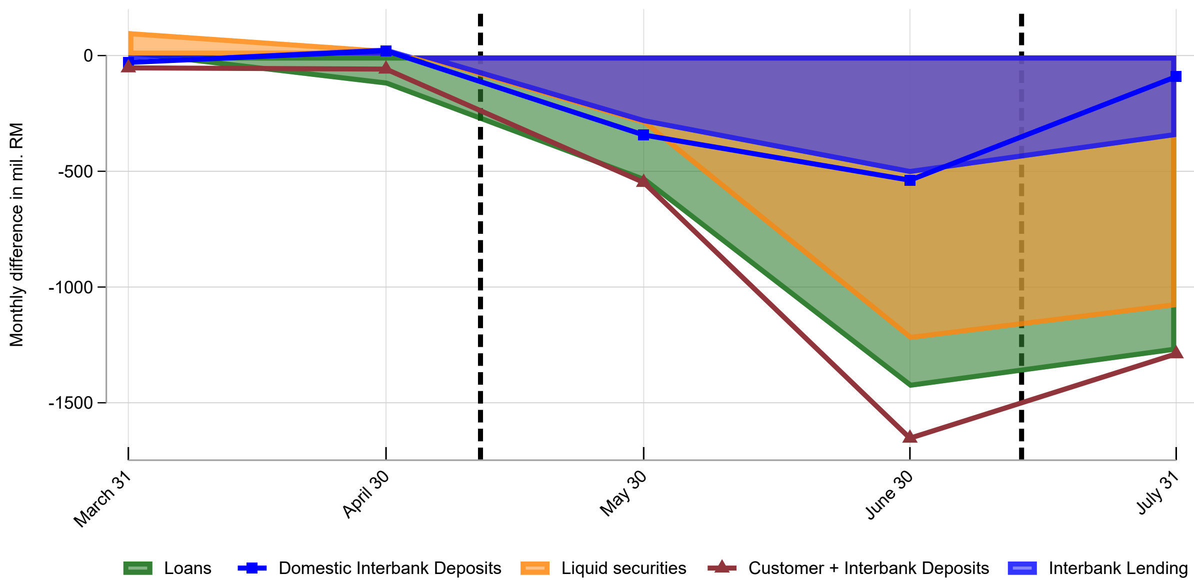
[14] A maximum of 200 RM per account per day could be withdrawn per account.

[15] The failing Danatbank and Dresdner Bank were merged and recapitalized by the government.

[16] Figure A.3 in the Appendix also plots the aggregate levels of bank assets and liabilities in the period before, during, and after the crisis.

[17] By definition, interbank claims and interbank deposits need to add up in the aggregate. While the change in interbank deposits is almost equal to the change in interbank claims, the difference can be explained by the fact that while our data cover most important banks our coverage is not complete and misses the interbank movements stemming from savings banks.

Figure 1: ***Aggregate Dynamics of Assets and Liabilities.***



Notes: The figure shows the month-on-month aggregate changes of key balance sheet components during the crisis in 1931 reported in the *Deutscher Staats- und Preussischer Reichsanzeiger*. Lines depict liabilities, such as domestic interbank borrowing (in blue) and the sum of all deposits (in dark red). Solid areas denote key assets such as illiquid assets (primarily loans and covered bonds in green), liquid assets (in yellow) and inter-bank lending (in blue). The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, and corresponds to the failure of Danatbank and the start of the banking holiday.

model:

$$y_{bt} = \gamma_b + \sum_{t \neq \text{April 1931}} \beta_t \times \gamma_t + \epsilon_{bt}, \tag{1}$$

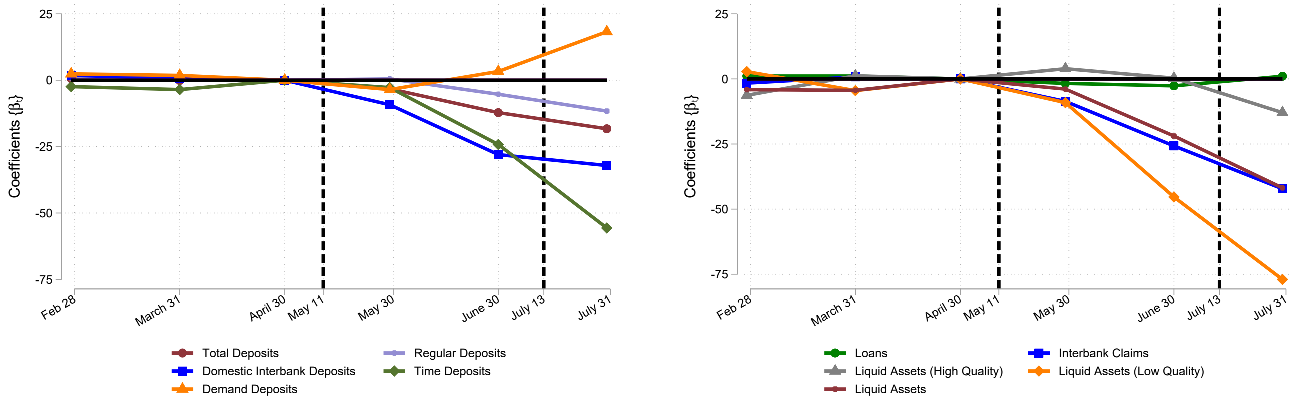
where y_{bt} is the natural logarithm of one plus either bank b's deposits (total, interbank, demand, and time deposits) or bank b's assets (high- and low-quality liquid assets, interbank claims, and loans and mortgages). Further, γ_b is a set of bank fixed effects to ensure a within-bank-across-time comparison. Finally, we normalize the set of time-varying coefficients $\{\beta_t\}$ to April 1931.

Figure 2 shows results for the dynamics of deposits in Panel (a) and assets in Panel (b). In line with the dynamics of aggregate deposits, initially only interbank deposits contract. We estimate that interbank lending falls on average by around 10% in May. The interbank market continues to collapse throughout the run and on average, interbank deposits decline by more than 30% by July. Further, the effect is also statistically significant in every month after April 1931; see Figure A.6 and Figure A.7 in the Appendix for point estimates with confidence bands.

In contrast to interbank deposits, regular deposits are stable throughout May. However, regular deposits start to contract in June, when they fall around 10% and by July they have contracted by more than 15%, with the effect again being statistically significant. Thus, while the run starts out as a run of

Figure 2: ***Deposit and Asset Dynamics during Spring 1931.***

(a) *Deposits* **(b)** *Assets*



Notes: The above figures display the sequence of coefficients $\{\beta_t\}$ that results from estimating the model:

$$y_{bt} = \gamma_b + \sum_{t \neq \text{April 1931}} \beta_t \times \gamma_t + \epsilon_{bt},$$

where y_{bt} is the natural logarithm of one plus either a bank b's deposits (total, interbank, demand, and time deposits) in panle (a) or bank b's assets (liquid assets net of interbank claims by quality, interbank claims, and credit) in panel (b). We multiply y_{bt} with 100 to convert the coefficients into percentage points. γ_b is a set of bank fixed effects. We weight each observation by bank size and normalize the set of time-varying coefficients $\{\beta_t\}$ to April 1931. Data are from the *Deutscher Staats- und Preussischer Reichsanzeiger*. Figure A.6 and Figure A.7 show the estimates with confidence bands.

banks on banks in May, it turns into a broader run that includes withdrawals by other depositors in June and July. Given that interbank deposits are a relatively small share of overall deposits, there is no decline in total deposits throughout May. However, given the relative importance of regular deposits for total deposits, total deposits also start to contract together with regular deposits in June and July. We estimate that the average bank loses around 15% of its deposits by the end of June and 20% by the end of July after the breakdown of the banking system and the start of the banking holiday.

As discussed above, our data allow us to distinguish between standard demand deposits with a maturity of less than 7 days and time deposits with a maturity between 7 days and more. Note though that time deposits could also be withdrawn at any time, although these withdrawals would be subject to a penalty.

In Panel (a) of Figure 2 we estimate that on average, demand deposits are stable in the first two months of the run and actually increase in the last months. Hence, the drop in overall deposits is entirely driven by an outflow in time deposits which decline by around 55% by July. The fact that demand deposits do not fall throughout the run is a striking finding as all deposits including demand deposits are uninsured. The finding is thus seemingly incongruent with standard bank run theories, which predict that uninsured debt claims with the shortest maturity are most likely to be withdrawn first in a crisis.

While demand deposits were most commonly held by retail depositors such as households, time deposits were more akin to modern-day wholesale funding as they carried considerably larger interest payments and tended to be held by corporations and wealthy investors. Hence, the stability of demand deposits can be rationalized by the fact that the latter type of depositor is arguably more sophisticated and more attentive.[18] Retail depositors started to withdraw across the board only when Danatbank declared bankruptcy, marking the third and final phase of the run (Born, 1967). However, the attempted withdrawals were immediately stopped by the bank holiday and thus not reflected in the data. The fact that retail depositors do not withdraw until the end of the Reichsbank liquidity support and the failure of Danatbank is in line with retail depositors having higher information acquisition costs and thus only paying attention in later stages of the run (He and Manela, 2016). The finding is also reminiscent of the difference in the behavior of retail and institutional investors in money market funds after the Lehman failure, when retail investors were much less likely to react to the shock (see Schmidt et al., 2016). Further, that depositors start a physical bank run once they learn that Danatbank defaulting suggests that they then revise their expectations massively once the aggregate liquidity shortage (Diamond and Rajan, 2005) becomes salient in the light of the failure of Danatbank.

Figure A.8 in the Appendix indeed shows that demand deposits, are in aggregate increasing slightly during the crisis, suggesting that some time deposits are being converted to shorter maturity demand deposits. The pattern of increasing rather than decreasing demand deposits can be rationalized by maturity shortening in time deposits (Brunnermeier and Oehmke, 2013) in which worried depositors—to the extent that they are not leaving the banking system—convert time deposits into demand deposits. The finding is also in line with the notion that term deposits in failing banks tend to be more sensitive to bank risk than demand deposits (Martin et al., 2022).[19]

Mirroring the outflows in deposits, Panel (b) of Figure 2 provides information on the dynamics of bank assets during the run. In line with the evidence in Figure 1, interbank claims decline throughout the run. Further, we find that high-quality liquid assets are stable throughout most of the run and only start to fall slightly in July. This pattern arguably reflects that banks are anticipating a higher value of high-quality liquidity in later stages of the run and prefer to deplete their low quality liquid assets first (Diamond and Rajan, 2011). As the withdrawal of regular deposits sets in in June, banks reduce their

[18] A complementary explanation would be that households may have less attractive outside options for having access to payment services and are thus more likely to stay in the banking system than wholesale investors.

[19] A similar pattern of low responsiveness of demand depositors is also evidenced by Ramirez and Zandbergen (2014) for the Panic of 1893 in the United States.

holdings of lower-quality liquid assets such as bills of exchange. They do so by discounting the claims at the Reichsbank's discount window in return for currency, which is then used to serve withdrawing depositors. As noted above, see Appendix A.3 for more details on the behavior of the Reichsbank. We estimate that by the end of July, banks have reduced their holdings of low-quality liquid assets by around 75% compared to April, mirroring the outflow of time deposits. In contrast, banks' illiquid assets contract much more slowly and by only around 10% from April through July.

5 Deposit Flows in Ex-Post Failing and Surviving Banks

We next turn to our main analysis and ask which depositors are withdrawing from failing banks. Our empirical strategy exploits the fact that we can observe the ex-post outcomes as to which banks fail throughout or in the aftermath of the crisis and which banks survive the crisis. While we have balance sheet information for more than 120 unique banks during the main phases of the crisis in 1931, 15 of these banks (around 12%) fail at some point during or in the aftermath of the run; see Panel A of Table A.1 in the Appendix for a list of failing banks and Figure A.9 for a timeline of the run and the failures.[20]

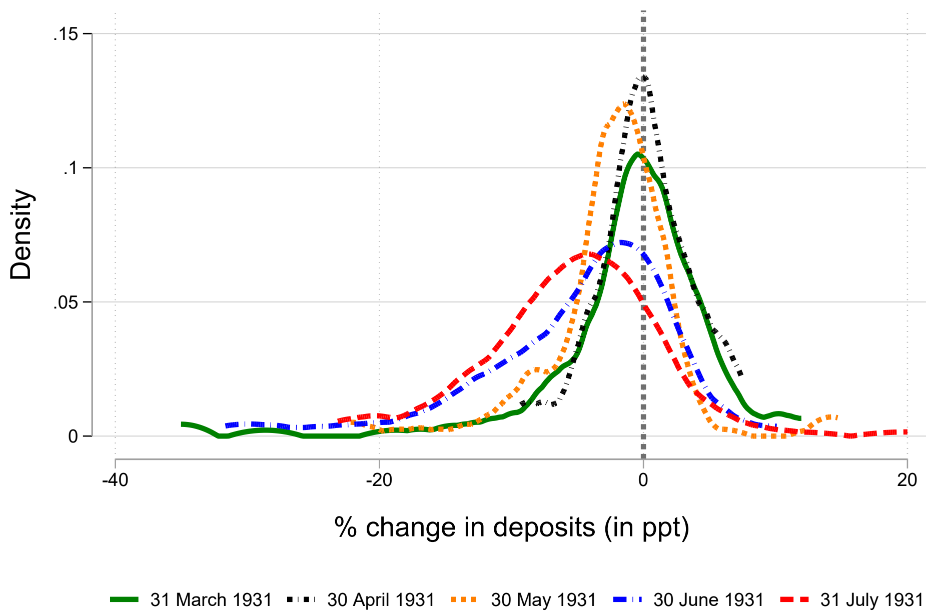
In the following, we use both cross-sectional variation in bank failures and deposit flows to analyze whether depositors withdraw more funds from banks that end up failing compared to banks that survive the run.

The Cross-section of Deposit Flows We start out by establishing that there is substantial cross-sectional variation in deposit flows during the run. Figure 3 plots monthly deposit growth from March through July 1931. Just before the crisis starts, in March and April of 1931, the distribution of monthly bank-level deposit growth is centered around zero, with some banks receiving deposit inflows and some being subject to outflows. The interbank market then re-allocates deposits from banks with inflow to those with outflows, and the banking system does not lose deposits, indicating successful risk-sharing (Allen and Gale, 2000). However, as the crisis starts, the average deposit growth rate turns negative. Notably, between May and July, some banks lose more than 20% of their entire deposit base per month.

[20]For our main analysis, we focus only on failed banks that declare bankruptcy during the acute phase of the crisis and its aftermath. I.e., these banks' equity was entirely wiped out at some point during or after the run. Four of these banks close during the run. One bank closes at the height of the run and right at the onset of the banking holiday. Another 8 fail in the immediate aftermath of the run while the banking system is being re-opened and finally another two fail within a year of the crisis. Note that all results are robust to dropping banks that fail at later stages, see Table A.10 in the Appendix.

However, throughout the entire run phase, there are always some banks that continue to receive deposit inflows.

Figure 3: ***The Cross-section of Deposit Flows through Spring/Summer 1931***



Notes: This figure depicts the kernel density of monthly bank-level log-changes (in ppt) of total deposit funding from March 1931 to July 1931. We depict each month separately. We include all banks reporting in *Deutscher Staats- und Preussischer Reichsanzeiger*.

Who Withdraws From Failing Banks? Combining the cross-sectional variation in both failures and deposit flows, we ask: do failing banks lose more deposits than surviving banks? We estimate a model of the following form

$$\Delta y_{b\text{April 31:July 31}} = \gamma_\theta + \beta_1 \times \text{Failed}_b + \beta_2 \times X_b + \epsilon_b, \tag{2}$$

where $\Delta y_{b\text{April 31:July 31}}$ is the log-growth in deposits y_b between the end of April and the end of July, i.e., from just before the failure of the Creditanstalt to just after the collapse of the entire banking system and the start of the bank holiday.[21] As indicated above, for y_b we use interbank and regular, time and demand, and total deposits. Also, as above, γ_θ is a set of bank-type fixed effects that ensures a within-bank-type comparison. Failed_b is a dummy if bank b failed sometime during or after the run[22]

[21]For our main specifications, we calculate the growth rate as $\Delta y_{b\text{April 31:July 31}} = \ln(1 + y_{b\text{July 31}}) - \ln(1 + y_{b\text{April 31}})$. In the Appendix in Table A.3 we show that our results are unchanged when calculate the growth rate $\Delta y_{b\text{April 31:July 31}} = \ln(y_{b\text{July 31}}) - \ln(y_{b\text{April 31}})$. The facts that the results are unchanged is unsurprising as almost all banks report a positive balance of interbank deposits.

[22]In robustness checks in Table A.9 in the Appendix, we also show that our results are robust to using the more general definition of 'bank distress' where we also define banks as distressed when they did not fail but when they received government

and our coefficient of interest is β_1, which measures the difference in deposit growth throughout the run between failed and surviving banks. Note that banks drop from our sample once they have failed.[23]

We also include a set of observable bank characteristics X_b. For instance, to proxy the distance to default, we calculate the ratio of a bank's total liabilities (calculated as total assets net of equity) over a bank's equity. To proxy for a bank's (il)liquidity, we calculate the ratio of liquid security holdings and interbank claims over total deposits. This addresses the concern that depositors are more likely to withdraw at banks that appear more likely to become illiquid throughout the run. Further, we control for bank size using quartile indicators for size based on total assets. We also control for whether a bank relies on foreign-denominated deposits and thus address the concern that bank failures may primarily be a by-product of the run on the currency. Given the prominent role of the interbank market, we also control for the reliance on interbank funding measured by the share of interbank deposits over total deposits. Finally, given the prominent role of the bankruptcy of "Nordwolle", we also include a dummy of whether a bank has an observable relationship to this firm to test whether bank failures are driven by the failure of this larger borrower. We calculate all control variables as bank-level averages from February 1931 through April 1931. Note that except for the reliance on foreign currency denominated deposits, all the characteristics were in principle easily available to the depositors at the time via the sources we are using.

An important caveat is that we do not observe the ultimate cause of bank failures. Hence, we cannot identify whether withdrawal motives are based on the *prospect* of default or whether they are the *cause* of default. Said differently, failure could be the consequence of deposit flows and the interpretation of β_1 is not causal. However, to the extent that there is variation across different types of deposits, we are nonetheless able to identify heterogeneity in depositor information. Variation in the contraction of deposit flows (or the lack thereof) across failing and surviving banks allows to understand whether depositors can tell which banks will fail or not. Variation across different types of deposits can give a sense whether some depositors are better at anticipating which banks will fail or not. Thus, our research objective allows us to remain agnostic about the causes of failures. For instance, we cannot tell

aid or were subject to a distressed merger, both also signs of a bank's weakness, see Panel B of Table A.1 for a list of these banks.

[23]Hence, when explaining deposit flows from April 1931 through July 1931, we effectively drop four banks that fail before the banking holiday: "Bankhaus Buehl", "Hansabank", "Gewerbebank AG", and "Landesbank der Rheinprovinz", see Table A.1 in the Appendix. Banks are dropped either because they stop reporting balance sheets after their failure or we drop them to rule out that our findings are driven by interventions that happen after the bank's failure and affect balance sheets. Note that we include the "Danatbank" balance sheet information for July 1931 as it reflects the bank's positions from right before the banking holiday which effectively froze the balance sheet. Results are robust to dropping Danatbank as well.

whether a bank would have failed even in absence of withdrawals (fundamental failure) or due to the withdrawals (panic-based failure).[24]

Table 2 shows our results. There is no statistically significant difference in the growth of regular deposits between failing and non-failing banks throughout the run; see columns (1) and (2). The point estimates suggest that regular deposits grow at a slightly lower rate at failing banks but the confidence bands suggest that total deposit funding at most falls by 10 percentage points more at failing banks than at surviving banks. However, the confidence bands also allow for the possibility that deposits increase by 6 percentage points less for failing banks. This finding is striking because in Figure 2 we estimate that regular deposits fall by more than 15% from April through July. Moreover, recall that all types of depositors should expect to realize losses if their bank were to fail. Yet, while deposits are falling substantially there is no statistically significant difference between failing and surviving banks. Hence, regular depositors either don't withdraw at all, or to the extent that they do withdraw, they do not discriminate between weak and strong banks.

In contrast to regular deposits, there is a substantial difference in the growth of domestic interbank deposits between failing and surviving banks. Interbank deposits fall by around 71-76 percentage points more at failing banks than at surviving banks; see columns (3) and (4). The magnitude is remarkable since we estimated in Figure 2 that banks on average lose around 30% of their interbank funding. This implies that while surviving banks see essentially no changes in their domestic interbank deposits from April through July, those banks that end up failing lose approximately 70%. Thus, failing banks, while not losing more regular deposits throughout the run, effectively lose access to the interbank market.[25]

This striking result on the difference between regular and interbank deposits can also be visualized by considering the density of the log-growth in regular and interbank deposits from April through July while splitting the sample into failing and surviving banks; see Figure 4. Panel (a) plots distribution of growth in regular deposits and reveals that—while deposits decline on average for both types of banks—there is no obvious difference in the flow of regular deposits across failing and surviving banks. The negative mean of the distribution shows that most both types of banks are subject to net outflows in deposits throughout the run. Notably, there are both failing and surviving banks that receive inflows of

[24]Our approach also allows for the possibility that some banks do not fail for some other reason such as political connectedness and anticipated government support. We are only interested in whether some depositors have more information about whether a bank will survive or not, abstracting from why it will fail or survive.

[25]Note that we also test the hypothesis that the relationship between failure and interbank deposits is the same as the relationship between failure and the other types of deposits reported in Table 2. In unreported results, we estimate seemingly unrelated regressions (SUR) and find that this hypothesis can be rejected with a p-value of just above or below 1%, depending on which columns we compare column (3) and (4) to.

Table 2: ***Deposit Flows from April 1931 through July 1931 for Both Failing and Surviving Banks*.**

Dep. variable	Regular		Interbank		Demand		Time		Total	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Failed	-2.1	-4.3	-69.7***	-76.1***	-4.9	-2.8	-12.0	-15.3*	-0.8	-2.5
	(4.4)	(4.4)	(24.5)	(25.0)	(12.3)	(11.5)	(8.6)	(7.8)	(3.8)	(3.5)
Leverage		-0.1		0.7		1.0**		-0.3		0.0
		(0.2)		(0.9)		(0.4)		(0.3)		(0.1)
Liquidity		-21.0***		-22.1		-4.3		-23.4**		-15.7***
		(5.6)		(32.0)		(14.7)		(9.9)		(4.5)
2nd Size quartile		-3.1		-10.9		-7.1		-12.9**		-3.8
		(3.5)		(19.9)		(9.2)		(6.2)		(2.8)
3rd Size quartile		2.9		17.3		17.6		-5.9		5.0
		(4.0)		(22.9)		(10.6)		(7.1)		(3.2)
4th Size quartile		5.1		42.4		24.7		-7.2		5.0
		(5.7)		(32.3)		(14.9)		(10.0)		(4.6)
Interbank Funding		0.9		20.3		64.8***		-64.4***		-8.9
		(8.8)		(50.2)		(23.2)		(15.6)		(7.1)
Foreign Funding		-6.2		-72.4***		-8.6		-11.6		-11.3***
		(4.7)		(26.4)		(12.2)		(8.2)		(3.7)
Nordwolle Connection		-5.4		18.7		6.5		-14.3		-5.0
		(7.4)		(42.0)		(19.4)		(13.0)		(6.0)
Number of Banks	118	118	118	118	118	118	118	118	118	118
Bank Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
R^2	.0019	.15	.067	.15	.0014	.24	.017	.3	.00045	.23

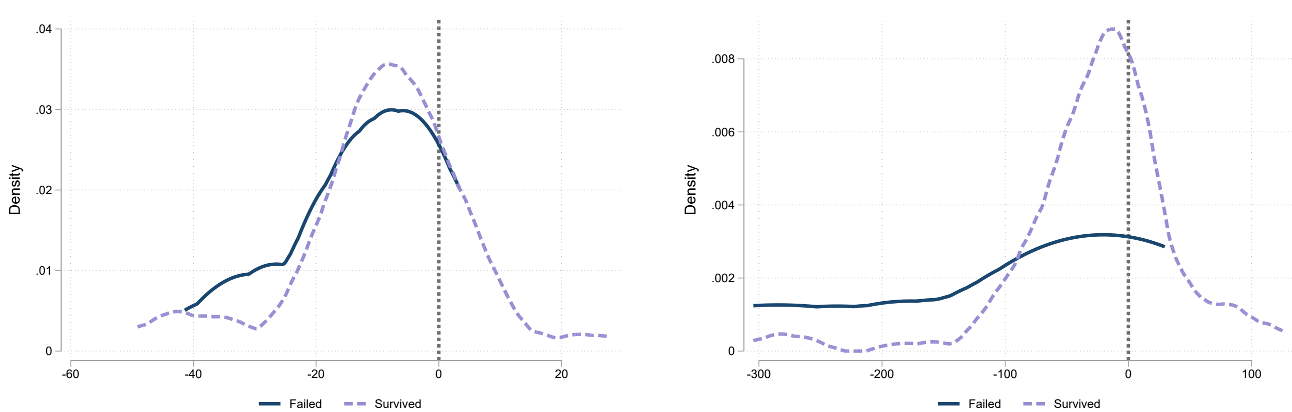
Notes: This table reports results from estimating

$$\Delta y_{b\text{July 31:April 31}} = \gamma_\theta + \beta_1 \times \text{Failed}_b + \beta_2 \times X_b + \epsilon_b,$$

where $\Delta y_{b\text{July 31:April 31}}$ is the log-growth of the given type of deposits for bank b from April 1931 through July 1931, as indicated in the table header. Failed_b is a dummy that indicates whether bank b failed during or after the run. We calculate the log-growth rate as $\Delta y_{b\text{April 31:July 31}} = 100 * [\ln(1 + y_{b\text{July 31}}) - \ln(1 + y_{b\text{April 31}})]$. The model is estimated using the cross-section of banks that report balance sheets in July 1931 in the *Deutscher Staats- und Preussischer Reichsanzeiger* and dropping banks that have failed before the banking holiday of July 1931. In columns (2), (4), (6) and (8), we include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits (1 implies the use of foreign deposits), and an indicator for whether a bank was connected to the non-financial firm "Nordwolle", which declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. Standard errors are shown in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Figure 4: ***Deposit Growth from April 1931 through July 1931 for Failing and Surviving Banks.***

(a) *Regular Deposits* **(b)** *Interbank Deposits*



Notes: This figure plots the kernel density functions for the log-change (in ppt) in total deposits (Panel (a)) and interbank deposits (Panel (b)) from April 1931 through July 1931 , splitting the sample into banks that failed and those that survived. Data from *Deutscher Staats- und Preussischer Reichsanzeiger*.

total deposit funding.

Panel (b) plots the distribution of growth in interbank deposits and reveals a striking difference between failing and surviving banks. On average, there is almost no contraction in interbank deposits for surviving banks and there are many surviving banks that see their interbank liabilities grow throughout the run. In contrast, there are almost no failing banks that increase their interbank borrowing and most density is to the far left, indicating that failing banks lose access to the interbank market.

Interbank deposits, however, are a relatively small part of overall deposit funding. Thus, their higher outflows at failing banks do not translate into a statistically significant difference and the above findings imply that there is no net difference in the outflow of total deposits—the sum of regular and interbank deposits—between failing and surviving banks; see column (9) and (10) of Table 2.

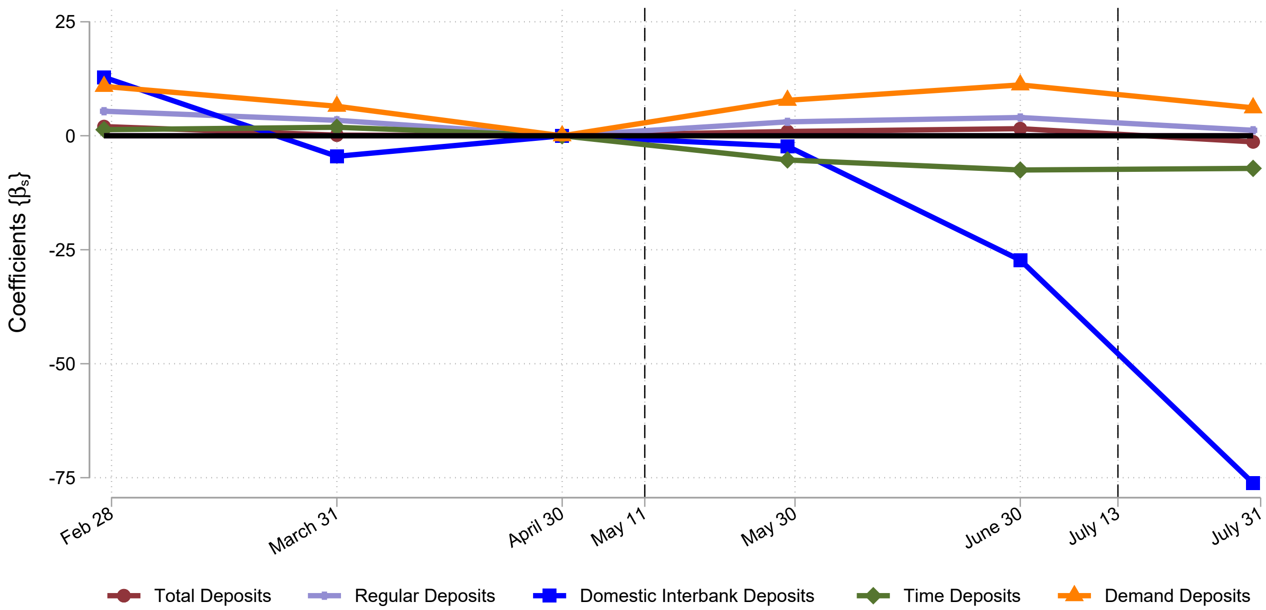
Aside from the regular and interbank deposits, we also distinguish between time and demand deposits. We find that failing banks are subject to relatively higher growth of demand deposits and the inflow of demand deposits is mirrored by an outflow in time deposits, with only the latter being statistically significant and only if control variables are included. Unfortunately, as described in Section 3, our data do not allow us to distinguish whether the outflow in time deposits is primarily from interbank deposits or regular deposits. Thus, we distinguish whether the outflow in time deposits is driven by the outflow of interbank time deposits or outflows of regular time deposits.

Dynamics Next, we analyze the dynamics of deposit flows for failed and surviving banks in more detail. Here, we estimate a model of the following type:

$$y_{bt} = \gamma_b + \gamma_{\theta t} + \sum_{s \neq \text{April 31}} \beta_s \times \mathbb{I}[s = t] \times \text{Failed} + \sum_{s \neq \text{April 31}} \mu_s \times \mathbb{I}[s = t] \times X_b + \epsilon_{bt}. \tag{3}$$

where y_{bt} is the log of one and bank b's deposits in RM at month t. As in Equation (1), γ_b represents bank fixed effect. Further, $\gamma_{\theta t}$ denotes bank-type-time fixed effects to control for differences across the different types of banks. Failed_b is as before a dummy that indicates whether bank b failed during or after the run. We are now interested in the sequence of coefficients $\{\beta_s\}$ that shows relative change in deposits for failed banks over surviving banks at time $s \in \{\text{February 1931}, ..., \text{July 1931}\}$. This allows us to study to what extent deposit flows are similar before the crisis and at what time relative differences start to occur. Note that we also include our control variables X_b and allow the relationship of deposit

Figure 5: ***Deposit Dynamics for Failed Banks.***



Notes: The figure displays the sequence of coefficients $\{\beta_s\}$ that results from estimating the model:

$$y_{bt} = \gamma_b + \gamma_{\theta t} + \sum_{s \neq \text{April 31}} \beta_s \times \mathbb{I}[s=t] \times \text{Failed}_b + \sum_{s \neq \text{April 31}} \mu_s \times \mathbb{I}[s=t] \times X_b + \epsilon_{bt},$$

where y_{bt} is the log of one plus the type of deposit indicated in the figure for bank b in month t. We multiply y_{bt} with 100 to convert the coefficients into percentage points. Failed_b is an indicator of whether a bank fails during or after the run. X_b is a set of bank-level control variables. We include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle", which declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. The model is estimated using balance sheets reported from February through July 1931 in the *Deutscher Staats- und Preussischer Reichsanzeiger*, dropping banks once they have failed. Finally, γ_b are bank-level fixed effects. The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, and corresponds to the failure of Danatbank and the start of the banking holiday. Figure A.11 in the Appendix shows the estimates for each type of deposit in separate plots including confidence bands.

flows and controls to change over time. As above, we drop a bank once it has failed.[26]

Figure 5 shows our findings for regular, interbank, time, demand, and total deposits. First off, there are no differences in deposit flows across failing and surviving banks before the run starts after the failure of the Creditanstalt in May. Further, in line with our results from estimating Equation (2), we find that interbank deposits start to change relatively more rapidly for failing banks starting in June 1931. By June, failing banks report 40% less interbank deposits relative to surviving banks, and by July, the difference has grown to more than 70%. As before, there is virtually no difference in the change in regular deposits across failing and surviving banks throughout the run. Regular deposits if at all increase at failing banks during the early phase of the run, possibly because failing banks offer higher rates on regular deposits for raising funds to make up for the lost interbank funding as in the model by Egan et al. (2017) and an empirical pattern also documented for recent failures of U.S. banks by, e.g.,

[26]Unlike to the cross-sectional analysis above, note that this implies in the panel regression that we include banks that end up failing until they fail, making the panel unbalanced. Results are robust to dropping these early failing banks.

Martin et al. (2022).[27]

Figure 5 also confirms the pattern of maturity shortening throughout the different phases of the run discussed above: in May, failing banks see 10% more growth in demand deposits while they also see around 10% lower levels of time deposits. Further, note that the effect is—unlike in Table 2—initially statistically significant, as shown in Figure A.11 in the Appendix. This findings suggests that some depositors at failing banks take a more cautious stance early in the run and convert their time deposits into demand deposits.

Predicting Which Banks Will Fail To further corroborate the finding that interbank flows anticipate bank failures, we ask whether bank failures can indeed be predicted with deposit growth rates. To this end, we reverse the original empirical specification in Equation (2). We now relate bank failures to observable characteristics of banks but also to their deposit flows throughout the run. This approach is especially useful as it allows us to also evaluate the area receiver operating characteristics curve (AUC) which quantifies by how much of both total deposit flows and interbank deposit flows help improve the econometrician's ability to predict which banks will fail.

Specifically, we estimate a model of the following type

$$\begin{aligned} \text{Failed}_b = & \gamma_\theta + \beta_1 \times X_b + \beta_2 \times \Delta \text{Interbank Deposits}_{\text{April 31:July 31}} \\ & + \beta_3 \times \Delta\ \text{Deposits}_{\text{April 31:July 31}} + \epsilon_b, \end{aligned} \tag{4}$$

where Failed_b is as before a dummy that indicates whether bank b failed during or after the run, γ_θ is a set of bank-type fixed effects and X_b is the set of bank-level characteristics described above. $\Delta\text{Interbank Deposits}_{\text{April 31:July 31}}$ is the growth in interbank deposits at bank b from April 1931 through July 1931; $\Delta\ \text{Deposits}_{\text{April 31:July 31}}$ is the growth of total deposit funding. We are interested in the statistical significance of the coefficients on deposit flows but we also study the area under the receiver operating characteristics curve that plots the true positive probability against false positive probability and allows to gauge the predictive power of the model.

We estimate various versions of Equation (4). First, we estimate the model without including interbank deposit flows but just bank characteristics observable from before the run. This specification

[27] We cannot observe the deposit rates offered by banks. However, our findings are in line with failing banks increasing rates on regular deposits at the margin to make up for the lost interbank funding. Acharya and Mora (2015) also discuss a similar mechanism in which banks with higher liquidity shortfalls during the GFC attempted to attract funding by offering higher rates.

is useful as it allows to test whether observable characteristics from before the run and in principle available to contemporary depositors[28] allow to predict failures. Second, we include the growth of interbank deposits and total deposits from April 1931 through July 1931 each separately and together. This allows to understand to which extent interbank deposit and total deposit growth each increase the ability to predict bank failures. Finally, further below we also estimate a slightly different variant of the model that allows for a non-linear relationship of bank failure and interbank deposit flows.

Table 3 shows results. Columns (1) and (2) show results from estimating Equation (4) when excluding deposit flows as an explanatory variable. This is a useful benchmark for what follows. We find that there is only limited explanatory power when using ex-ante balance sheet characteristics. There is no systematic pattern for how balance sheets characteristics relate to bank failure.

Next, in columns (3) through (6), we include either growth in interbank funding or total deposit funding during the run as an explanatory variable. We find that interbank deposits indeed predict failure as evidenced by the statistically significant coefficient, which shows that banks with less interbank deposit outflows (higher interbank deposit growth) are less likely to fail. We find that a 10ppt higher growth rate interbank funding is associated with an around 10-11 percentage points higher chance of survival. In contrast, total deposit funding has no predictive power. This is also true when including both as explanatory variables, see columns (7) and (8). Table A.7 in the Appendix also shows that these findings are broadly robust to estimating the model using Probit rather than OLS.

Further, we also estimate a slightly modified model that takes into account that the relation between interbank deposit flows and failure can be non-linear—with for instance only very substantial outflows being associated with bank failure but moderate interbank deposit outflows having little predictive power. To that end, we calculate dummies that indicate the quintile of the growth from interbank deposits from April 1931 through July 1931 for each bank and calculate the probability of failure for each quintile. We report the results of the regression in Figure 6. The pattern is clear: there is a monotonic but non-linear relationship between interbank funding growth and the probability of failure. We find that firms with very heavy outflows (in the lowest quintile of the interbank deposits growth distribution) are most likely to fail. For instance, being in the lowest quintile implies that the chance of failure is around 40% and thus considerably higher than the unconditional probability of failure of around 10%. In contrast, being in the second or third quintile of the interbank funding growth distribution implies a

[28] As noted above, bank level characteristics were available to depositors apart from the exposure to using foreign-currency denominated deposits.

Table 3: ***Predicting Bank Failure With and Without Deposit Flows.***

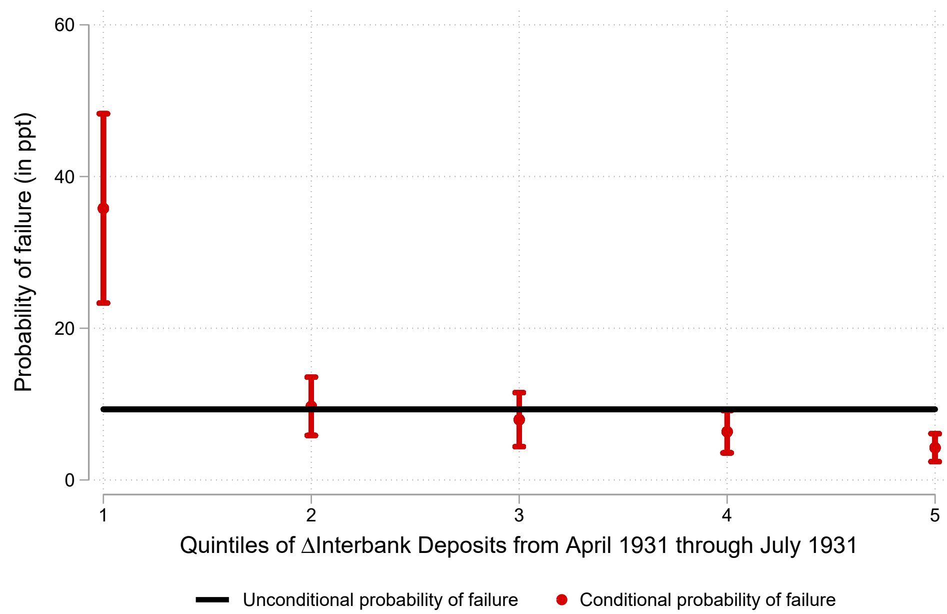
Dependent variable	Failed							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔInterbank $\text{Deposits}_{\text{April 31:July 31}}$			-11.57**		-11.10**		-11.79*	-11.46**
			(5.51)		(4.84)		(6.19)	(5.45)
$\Delta$$\text{Deposits}_{\text{April 31:July 31}}$				-30.00		-25.32	4.24	6.84
				(27.16)		(25.88)	(32.48)	(30.43)
Leverage	0.01	0.17	-0.02	-0.01	0.23	0.18	-0.02	0.23
	(0.12)	(0.18)	(0.12)	(0.12)	(0.18)	(0.18)	(0.11)	(0.18)
2nd Size quartile	11.04	-2.41	8.35	9.40	-3.58	-3.56	8.52	-3.31
	(8.65)	(9.50)	(8.26)	(8.83)	(8.90)	(9.71)	(8.17)	(8.90)
3rd Size quartile	-1.36	-12.37	0.41	-0.05	-9.49	-11.14	0.26	-9.73
	(6.75)	(8.67)	(6.86)	(6.63)	(8.07)	(8.49)	(6.84)	(8.06)
4th Size quartile	-4.90	-6.03	-0.31	-3.46	-1.04	-5.00	-0.43	-1.15
	(6.57)	(8.61)	(6.33)	(6.37)	(8.34)	(8.60)	(6.17)	(8.31)
Foreign Funding	0.95	-2.48	-7.34	-3.02	-10.55*	-5.61	-6.94	-9.96
	(3.52)	(4.94)	(5.34)	(3.89)	(6.34)	(5.36)	(4.71)	(6.02)
Liquidity	6.14	-15.30	1.69	0.43	-16.78	-19.58	2.41	-15.67
	(11.57)	(11.08)	(10.68)	(13.09)	(11.01)	(12.55)	(13.25)	(13.10)
Interbank	4.38	22.72	2.22	2.02	23.02	20.28	2.52	23.69
	(8.80)	(19.02)	(9.06)	(8.19)	(19.11)	(18.43)	(8.33)	(18.70)
Nordwolle Connection	17.61	20.13	19.06	15.02	19.64	17.68	19.46	20.29
	(15.32)	(16.93)	(15.31)	(13.88)	(16.20)	(15.38)	(14.78)	(15.73)
Number of Banks	118	118	118	118	118	118	118	118
Bank-Type FE	No	Yes	No	No	Yes	Yes	No	Yes
R^2	.073	.17	.15	.083	.24	.17	.15	.24
main								
AUC	0.582	0.810	0.723	0.614	0.826	0.812	0.721	0.822

Notes: This table reports result from estimating a regression of the following form:

$$\text{Failed}_b = \gamma_\theta + \beta_1 \times X_b + \beta_2 \times \Delta\text{Interbank Deposits}_{\text{April 31:July 31}} + \beta_3 \times \Delta\ \text{Deposits}_{\text{April 31:July 31}} + \epsilon_b,$$

where Failed_b is, as before, a dummy that indicates whether bank b failed during or after the run. Our variables of interest are the changes in interbank deposits between April and July of 1931 as well as the changes in total deposit funding over the same period. γ_θ is a set of bank-type fixed effects and X_b is a set of bank-level characteristics in which we include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle" that declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. Standard errors are in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. The final row reports the area under receiver operating characteristics curve (AUC).

Figure 6: *Failure Probability Conditional on the Quintile of Interbank Deposit Growth During the Run.*



Notes: This figure shows the set of coefficients $\{\beta_{2,s}\}$ results from estimating the following model:

$$\text{Failed}_b = \beta_1 \times X_b + \sum_{s=1}^{5} \beta_{2,s} \times \mathbb{I}[\Delta \text{Interbank Deposits}_{\text{April 31:July 31}} \in Q_s](s) + \gamma_\theta + \epsilon_b,$$

where $\mathbb{I}(s)$ is an indicator that takes the value one if the growth if interbank deposits lies in quintile Q_s. Note that we suppress the constant and thus $\beta_{2,s}$ can be interpreted as the probability of failure conditional on being in quintile s of the interbank deposit growth distribution.
As control variables, X_b, we include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle" that declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. The model is estimated using the cross-section of banks that report balance sheets in July 1931 in the *Deutscher Staats- und Preussischer Reichsanzeiger* and dropping banks that have failed before the banking holiday of July 1931. 95% confidence bands applied.

probability of failure that is similar to the unconditional failure probability. Further, being in the 4th or 5th quintile implies a probability of failure that is significantly lower than the unconditional failure probability.

To formally understand how powerful interbank flows are in predicting bank failure, we next use a standard tool used to evaluate binary classification ability, the receiver operating characteristic curve (ROC) as is also done in, e.g., Schularick and Taylor (2012). To gauge the ability to predict which banks will fail we plot the area under the ROC curve (AUC). The AUC provides a simple test against the null value of 0.5 with an asymptotic normal distribution.

To visualize our main insights, we calculate and compare the AUC obtained from various versions of the regression model in Equation (4) and the specification underlying estimation of the coefficients shown in Figure 6. First, we compare the specification in column (1) in Table 3 and compare it to the specifications in columns (3) and (4) in the same table in which we control for either interbank deposit growth or total deposit growth. Finally, we compare all three to the AUC of the non-linear model in which we use the quintile indicators of the interbank deposit growth distribution as explanatory variables. We also report the AUC for all other estimated regression models at the bottom of Table 3.

Figure 7 shows our main insights. Our baseline model that excludes interbank deposit flows has an AUC of 0.58 and hence just above 0.5. Thus, trying to predict bank failure with observable balance sheet characteristics alone is only slightly better than tossing a coin. Thus, there is next to no chance of identifying a bank that will fail from these characteristics alone without having a very large number of false positives. Further, the AUC increases only minimally to just above 0.6 once we also control for the flow of total deposits. This is particularly striking as it emphasizes that the total shortfall of funding is about the same for both failing and surviving banks.

However, we find that the AUC increases substantially when including interbank deposit growth as an explanatory variable. Adding the interbank deposit flows to the predictive model, i.e., going from column (1) to column (3) increases the AUC from 0.58 to around 0.72. This is a substantial increase in the AUC. Hence, knowledge of interbank deposits growth throughout the run substantially increases the ability to tell which banks will fail. More than that, once we allow for the relation between failures and interbank deposit flows to be non-linear, the pattern becomes even clearer. The AUC goes up to 0.82. The model with an AUC of 0.82 performs very well in identifying failing banks. For instance, a policy maker with knowledge of contemporaneous interbank deposit flows and willing to accept a false positive rate of 0.5 could have identified almost around 90% of all failing banks during the run, see Figure 7.

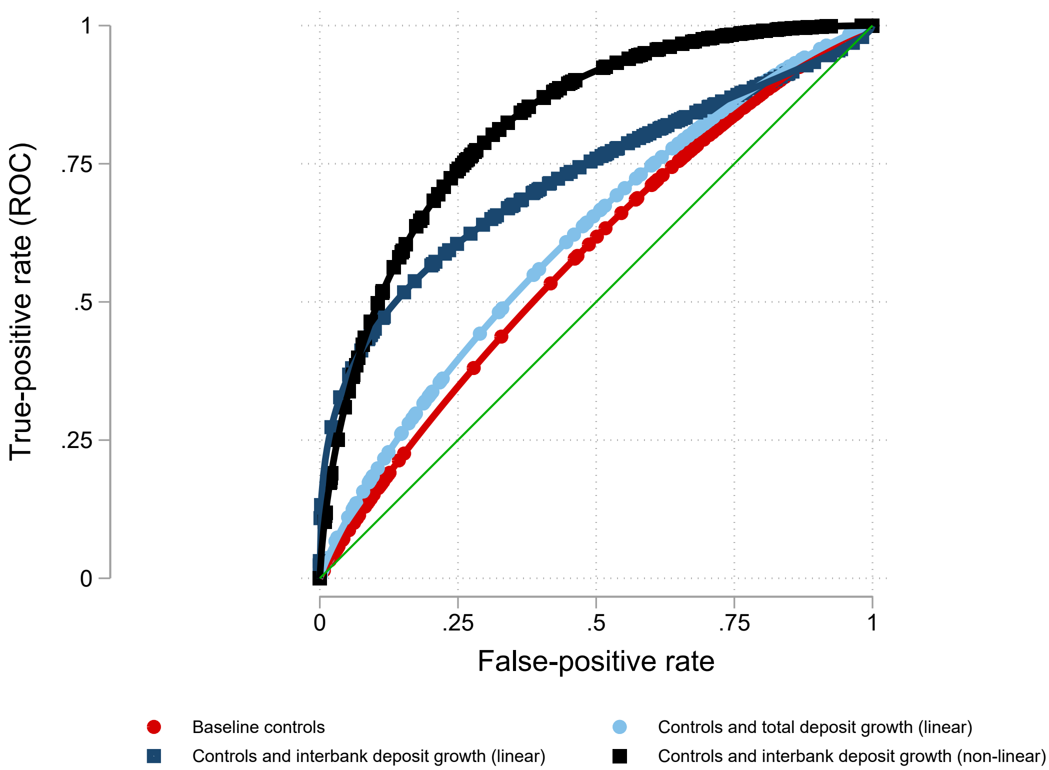
Our findings suggest that interbank deposits are a predictor of whether a bank will fail.[29] Further, the relationship is somewhat non-linear and substantial outflows in interbank funding are associated with an elevated chance of bank failure during the run. The outflow in regular deposits, in contrast, has little explanatory power for who will fail.

Are Banks Better Informed or Do Interbank Deposit Outflows Cause Failure? A priori, there at least two[30] equally plausible explanations for the finding that bank deposits decline almost exclusively for failing banks while regular deposits fall equally for both failing and surviving banks. On the one hand, banks may have been better informed than regular depositors and thus banks can discriminate between banks that end up failing and those that end up surviving and hence they withdraw from the

[29] Table A.11 shows that using time deposits as explanatory variable also yields a comparably high AUC but time deposits become statistically insignificant when included together with interbank deposit flows. As discussed above, time deposits can contain interbank deposits.

[30] We discuss other alternative explanations further below.

Figure 7: *Predicting Failure: Receiver operating characteristic (ROC) plot.*



Notes: This figure plots the receiver operating characteristics curve from estimating three versions of Equation (4) as estimated in Table 3 and Figure 6. The curve "Baseline controls" refers to the AUC corresponding to the estimates from column (1) of Table 3 and includes observable bank characteristics in which we include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle" that declared bankruptcy in June 1931. The curve "Controls and total deposit growth refers (linear)" corresponds to the estimation of column (4) of Table 3, which include the bank characteristics and a measure of total deposit changes over the crisis. The curve "Controls and interbank deposit growth refers (linear)" corresponds to the estimation of column (3) of Table 3 and includes the above-mentioned controls as well as a measure of interbank deposit changes at the bank over the crisis. Finally, the curve "Controls and interbank deposit growth refers (non-linear)" corresponds to the estimation from shown in Figure 6 and makes use of the above-mentioned controls as well as dummies for quintiles of interbank deposit growth.

former to protect themselves against potential losses. One the other hand, the fact that some banks lost access to the interbank market could have been the immediate cause of bank failure.

While both possible explanations are not mutually exclusive and in general both can be true at the same time, we believe, however, that the evidence suggests that the former explanation is more plausible. There are two main reasons why that is the case. First, recall that failing banks do not lose more *total* funding. Failing and surviving banks lose about the same percent of deposits despite the much higher interbank deposit outflows at failing banks since interbank funding is a relatively small share of total funding. However, standard models of bank runs suggest that the total shortfall of funding governs whether a bank becomes illiquid first and then insolvent (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005) as opposed to the composition of funding.[31] Hence, we argue that the decline in interbank funding alone is unlikely to be the immediate cause of the failures. This finding is reminiscent of the evidence by Perignon et al. (2018) who find that informed investors tend to withdraw but not cause the lower performance of weak banks when studying wholesale funding dry-ups during the European Debt Crisis.

Second, we also provide an explicit test on whether interbank deposit flows cause failure and study whether our results are robust to excluding banks that are more reliant on interbank funding. That is, we test whether our results are robust when estimating Equation (2) but using only banks that have relatively little reliance on interbank funding. before the run[32] For such a sub-sample, it is particularly implausible for interbank deposit outflows to be the immediate cause of the failure as they are a small share of overall funding to begin with. We thus estimate Equation (2) to study the growth of regular, interbank, and total deposit funding throughout the run when restricting the sample to banks with either less than 10%, 7.5% or 5% of their total deposits funding coming from with interbank deposits.[33]

The results can be found in Table 4 and confirm our main findings: regular and total deposits fall by about the same for both failing and surviving banks. In contrast, the difference in interbank deposits

[31]Further, note that interbank funding represents a from of wholesale funding that is typically assumed to be more expensive than regular deposit funding. Thus, if at all, failing banks are shifting their funding mix towards cheaper sources of funding.

[32]Figure A.10 in the Appendix shows that the distribution of total and interbank deposits to total assets is relatively similar for both ex-post failing and surviving banks. While the typical bank finances between 60% and 90% of its assets with deposits, most banks finance less than 10% of their total deposits funding from other banks. Further, there is no ex-ante difference between failing and surviving banks. If at all, failing banks are somewhat less reliant on interbank funding prior to the run. This is re-assuring, as it would be concerning if failing banks had more reliance on interbank funding to begin with. However, Figure A.10 also shows that there are a few banks that are financing a substantial portion of their overall investments via interbank market funding. This raises the possibility that those banks, which fail are relatively more reliant on interbank funding, are also those banks that are driving our main findings

[33]The results are also robust to when restricting the sample by using similar cutoffs for the ratio of interbank deposits and total assets.

Table 4: ***Deposit Flows from April 1931 through July 1931 for Failed Banks by Reliance on Interbank Market Funding as Share of Total Deposits Funding.***

Dep. variable	Regular			Interbank			Total		
Interbank share (in %)	< 10%	< 7.5%	< 5%	< 10%	< 7.5%	< 5%	< 10%	< 7.5%	< 5%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Failed	-0.5	-0.2	1.9	-135.5***	-124.7***	-112.9**	-2.2	0.8	3.1
	(4.4)	(5.1)	(4.8)	(36.3)	(41.6)	(44.6)	(4.3)	(4.7)	(4.6)
Mean LHS	-8.9	-7.8	-9	-41	-52	-53	-11	-11	-11
Number of Banks	66	49	40	66	49	40	66	49	40
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	.33	.22	.38	.36	.46	.43	.43	.47	.48

Notes: This table reports results from estimating

$$\Delta y_{b \text{April 31:July 31}} = \gamma_\theta + \beta_1 \times \text{Failed}_b + \beta_2 \times X_b + \epsilon_b,$$

where $\Delta y_{b \text{April 31:July 31}}$ is the log-growth in the type of deposit indicated in the table header. We restrict the sample to banks that use either less than 10%, 7.5% or 5% of interbank funding as a share of total deposit funding as indicated in the table header. As control variables, we include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle" that declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. The model is estimated using the cross-section of banks that report balance sheets in July 1931 in the *Deutscher Staats- und Preussischer Reichsanzeiger* and dropping banks that have failed before the banking holiday of July 1931. Standard errors are shown in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Standard errors are shown in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

remains statistically significant. For instance, we find that for the sample of banks with less than 10% of interbank funding prior to the run, interbank funding falls by around 40% on average—slightly higher than the 30% in the main sample—and the difference between failing and surviving banks is more than 100 percentage points (see column (4)). In contrast, there is no difference in the decline in regular or total deposit funding (see columns (1) and (7)). We interpret these findings as evidence that suggest that the outflow of interbank deposits alone is unlikely to be able to trigger a bank's illiquidty and insolvency.[34]

Alternative Explanations For the Main Findings Above, we considered what we believe are the two most obvious candidates to explain our main findings. We next discuss other alternative explanations.

A third alternative explanation would be that failing banks choose a different investment strategy than surviving banks during the run. This difference in asset selection, in turn, could then translate into a difference in the funding choices. We argue that this explanation is less plausible for the two following reasons. First, recall from Figure 5 that interbank funding drops very quickly during the

[34]Additional evidence comes also from studying differences across bank types and dropping those banks that are more active in the interbank market such as the Girozentralen, Landesbanken, and Berlin banks. In additional specification, we exclude these types of banks from our sample. In Table A.6 in the Appendix we estimate Equation (2) and show that failing regional banks do not experience higher outflows in regular deposits but get excluded from the interbank market.

run. Note though that a quick adjustment in the asset-side composition tends to be costly when liquidity dries up and bid-ask spreads widen. Hence, we argue that the pattern is more likely a result of depositors withdrawing funds that are available on demand as opposed to banks' asset selection. Second, Figure A.12 in the Appendix we also study the dynamic coefficients plot obtained when estimating Equation (3) using bank assets as outcome variables. We find that failing banks are – if at all – less likely to reduce their loan portfolio, in line with failing banks continuing to lend to their customers, indicating possible forbearance. Hence, we do not observe failing banks reducing their funding needs during the run.

A fourth explanation candidate are differences in opportunity costs. We can neither directly observe differences in information sets nor opportunity costs across different types of depositors. Hence, another potential concern stems from potentially unobservable differences in opportunity costs. Specifically, it may be more costly for a retail depositor to withdraw from a bank and invest funds someplace else than for bank. Hence, differences in opportunity costs may be affecting the observed outcomes and hence our interpretation of the findings. Note, however, that opportunity costs can only explain variation in the responsiveness of different types of depositors across time but not across failing and surviving banks. A depositor with relatively higher opportunity costs will plausibly withdraw later in the run (as distress becomes more severe). However, differences in opportunity cost cannot explain the fact that regular depositors do not distinguish between failing and surviving banks, as documented in Table 2. Thus, the fact that interbank deposits essentially collapse for failing banks but regular deposits do not can be explained by differences in information about prospective bank failure but not by differences in opportunity costs.

6 Interbank Market

The striking difference between interbank deposit flows for failing and surviving bank raises the intriguing question whether surviving banks can borrow from other banks when subject to deposit outflows. This question is especially intriguing as Figure 3 revealed that some bank continue to receive deposit inflows during the run. Hence, we next study the interbank market in more detail and whether there is reallocation within the interbank market. We ask: do banks with deposit inflows re-deposit within the interbank market or do they hoard cash and other liquid assets as suggested in theories by Caballero and Krishnamurthy (2008); Allen et al. (2009)?

To measure the activity in the interbank market, we construct a measure of each bank's exposure to the interbank market as follows:

$$\text{Interbank Exposure}_{bt} = \text{Interbank Lending}_{bt} - \text{Interbank Borrowing}_{bt}$$

That is, we define the interbank exposure of a bank as the relative difference between interbank claims and interbank deposits. We can then study the correlation of change in the exposure with the change in regular deposits, both normalized by bank size as measured by a bank's total assets.

In a normally functioning interbank market, one would expect that a bank with deposit inflows would lend out the received funds to those with deposit outflows and thus increase the interbank exposure. In contrast, a bank that is subject to deposit outflows would borrow through the interbank market and thus reduce its interbank exposure. See, e.g., Allen and Gale (2000) for a model of such interbank deposit flows in which the interbank market insures banks against bank-specific withdrawal shocks, suggesting a positive correlation of interbank exposure with regular deposit funding growth.

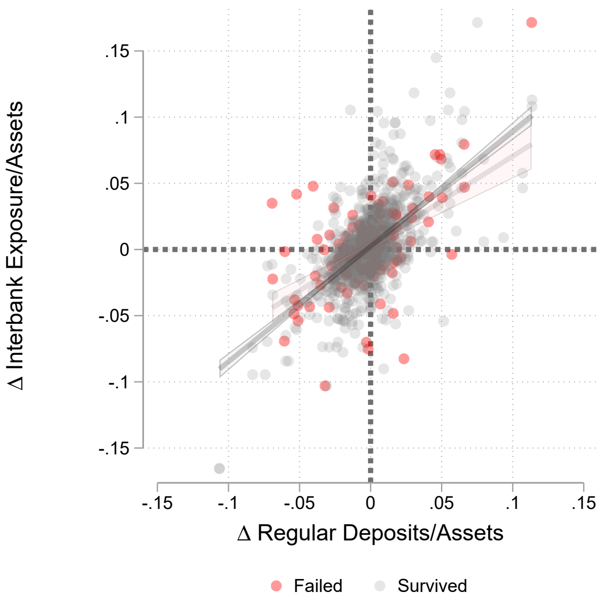
Figure 8 shows the relation of the month-to-month change in interbank exposure for failing and surviving banks for both the period before the run (Panel (a)) and during the run (Panel (b)). The positive correlation in Panel (a) confirms the theoretical notion of how interbank markets work and bank balance outflows by borrowing from banks with inflows. Indeed, before the run starts, both failing and surviving banks increase their interbank exposure in a month in which they receive deposit inflows and decrease their interbank exposure in a month in which they are subject to deposit outflows. Hence, the interbank market works and reallocates the funds effectively.

Panel (b), however, reveals a striking difference between failing and surviving banks during the run. The correlation between the change in interbank exposure and the change in regular deposits goes from close to 1 to zero and loses its statistical significance. Even more striking, however, is the positive correlation between interbank exposure and deposits for surviving banks, which remains close to one. Hence, while failing banks get excluded from the interbank market, surviving banks subject to deposit outflows in a given month continue to be able to borrow from those banks with deposit inflows. Said differently, banks with inflows of regular deposits during the run do not hoard the funds they receive but intermediate them to other surviving banks via the interbank market.

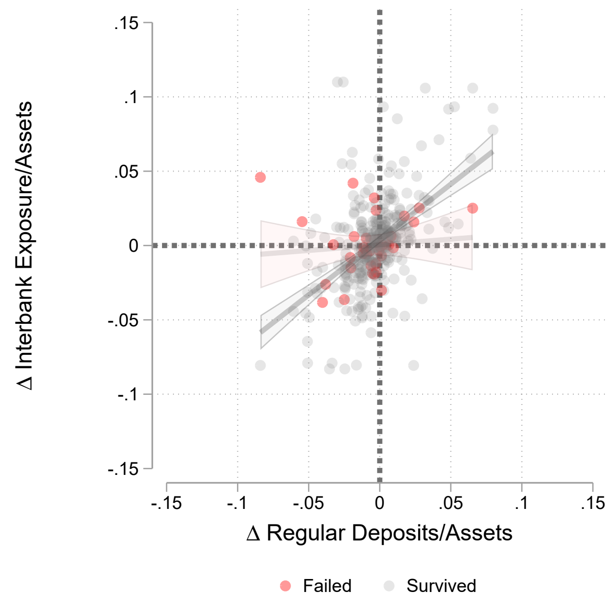
We also study the above relationship more formally and estimate the following model using data

Figure 8: ***Correlating Changes in Interbank Exposure and Regular Deposit Funding Before and During the Run.***

(a) *January 1930 through April 1931.*



(b) *May 1931 through July 1931.*



Notes: This figures relates banks' change in regular deposit funding (total deposits net of interbank deposits), normalized by total assets, to banks' interbank exposure defined as:

$$\Delta \text{Interbank Exposure} = \Delta[\text{Interbank Lending} - \text{Interbank Borrowing}].$$

The sample is split by whether a bank fails during or after the run or not. The left panel uses bank-level outcomes from January 1930 through April 1931. The right panel uses bank-level outcomes from May 1931 through July 1931.

from 1930 through July 1931:

$$
\begin{aligned}
\Delta\text{Interbank Exposure/Assets}_{bt} = & \gamma_b + \gamma_{\theta t} + \beta_1 \times \Delta\text{Reg. Deposits/Assets}_{bt} \\
& + \beta_2 \times \Delta\text{Reg. Deposits/Assets}_{bt} \times \text{Post}_t \\
& + \beta_3 \times \Delta\text{Reg. Deposits/Assets}_{bt} \times \text{Failed}_b \times \text{Post}_t \\
& + \beta_4 \times \Delta\text{Reg. Deposits/Assets}_{bt} \times \text{Failed}_b + \beta_5 \times \text{Failed}_b \times \text{Post}_t + \epsilon_{bt},
\end{aligned}
$$

where ΔInterbank Exposure/Assets$_{bt}$ is the change in interbank exposure normalized by assets from $t-1$ to t, ΔReg. Deposits/Assets$_{bt}$ is the same for regular deposit funding, Failed$_b$ is an indicator whether bank b fails during or after the run, and Post$_t$ is an indicator variable that turn one after April 1931 when the run starts.

Here, there are three coefficients of interest. β_1 is the average correlation between the change in interbank exposure and regular deposit flows (changes in total deposits net of interbank deposits). In a functioning interbank market, this coefficient should be close to one. β_2 is the relative difference in the relationship between changes in interbank exposure and deposit flows for all banks. If the interbank collapses for all banks, it should be a negative number close to -1. Further, β_3 is the relative change in the relationship between changes in interbank exposure and deposit flows during the run for failing banks alone.

Results can be found in Table 5. First, note that β_1 is indeed close to one, confirming the notion that in normal times, banks with deposit inflows increase their interbank exposure and banks with deposit outflows decrease it. β_2 is also statistically significant and negative in some specification. Thus, the overall intermediation is less during the run than before the run. However, the slope remains positive and relatively close to one and the interbank market as a whole does not collapse but functions under distress. Finally, note that β_3 indicates that the correlation is largely reduced for failing banks during the run, echoing the findings in Figure 8. I.e., the interbank market collapses mostly for failing banks.

As indicated above our sample does not cover the entire banking system but the subset of commercial banks. Eventual concerns that we only have data for a subset of the entire banking system are addressed by the fact that the interbank market Germany was segmented. In one part of the interbank market which we only have partially covered in our data, Landesbanken and Girozentralen interact with their associated local savings banks. In the second part, which our data covers entirely, commercial banks such as the Berlin banks and the regional banks would borrow and lend. Thus, it is re-assuring that we

Table 5: ***Interbank Exposure and Regular Deposit Flows Before and During the Run.***

Dependent variable	Δ Interbank Exposure		
	(1)	(2)	(3)
ΔReg. Deposits/Assets	0.90***	0.90***	0.85***
	(0.06)	(0.06)	(0.08)
ΔReg. Deposits/Assets×Post	-0.15	-0.10	-0.14
	(0.09)	(0.09)	(0.13)
ΔReg. Deposits/Assets×Post×Failed	-0.51**	-0.54**	-0.49*
	(0.22)	(0.24)	(0.25)
ΔReg. Deposits/Assets×Failed	-0.20	-0.17	-0.12
	(0.16)	(0.17)	(0.17)
Post×Failed	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
Sample	All Banks	All Banks	Berlin Banks + Regionals
N	1732	1732	1214
Number of Banks	130	130	92
Time FE	Yes	No	Yes
Bank Type Time FE	No	Yes	No
R^2	.4	.42	.39

Notes: This table reports results from estimating:

$$\begin{aligned}\Delta\text{Interbank Exposure}_{bt} = & \gamma_b + \gamma_{\theta t} + \beta_1 \times \Delta\text{Reg. Deposits/Assets}_{bt} + \beta_2 \times \Delta\text{Reg. Deposits/Assets}_{bt} \times \text{Post}_t + \beta_3 \times \Delta\text{Deposits/Assets}_{bt} \times \text{Failed}_b \times \text{Post}_t \\ & + \beta_4 \times \Delta\text{Reg. Deposits/Assets}_{bt} \times \text{Failed}_b + \beta_5 \times \text{Failed}_b \times \text{Post}_t + \epsilon_{bt},\end{aligned}$$

where ΔInterbank Exposure/Assets$_{bt}$ is the change in interbank exposure normalized by assets from $t-1$ to t, ΔReg. Deposits/Assets$_{bt}$ is the same for regular deposit funding, Failed$_b$ is an indicator whether bank b fails during or after the run, and Post$_t$ is an indicator variable that turn one after April 1931 when the run starts. Interbank exposure is defined as:

$$\text{Interbank Exposure}_{bt} = \text{Interbank Lending}_{bt} - \text{Interbank Borrowing}_{bt}$$

The model is estimated using the panel of banks that report data from February 1930 through July 1931 while dropping failing banks once they have failed. In column (3) we restrict the sample to Berlin bank and regional credit banks. Fixed effects as indicated in the table. Standard errors are clustered at the bank level and reported in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

can show that our results are robust to including either bank-type-time fixed effect or analyzing only Berlin banks and regional banks, see column (2) and (3) Table 5.

Table A.4 in the Appendix shows results when estimating a Probit model that uses an indicator whether a bank increases its interbank funding from $t-1$ to t as the dependent variable. Table A.5 shows results when using the change in interbank deposits as opposed to interbank exposure as the outcome variable. The findings confirm that banks tend to increase their interbank borrowing whenever faced with deposit outflows in normal times. This relationship continues to hold throughout the run for surviving banks but stops to hold for failing banks.

Taken together, our evidence on the dynamics of the interbank market stand in contrast to theories of liquidity hoarding by banks in times of distress (Allen et al., 2009; Caballero and Krishnamurthy, 2008) and interbank market contagion (Allen and Gale, 2000; Liu, 2016) as well as empirical findings that suggest that interbank market necessarily amplify financial distress (see, e.g., Mitchener and Richardson, 2019). However, our empirical findings complement and support the findings of Afonso et al. (2011) who show that the interbank market in the U.S. became more risk-sensitive during the GFC but continued to function. We show that for the run on the German banks in 1931, the interbank market continued to provide liquidity to surviving banks but not to failing banks for whom the interbank market collapses.

Discussion Altogether, we argue that our findings suggest that banks have the most information about the state of the banking system and are in effect the most sophisticated type of depositor. Banks seem to have information about which of their competitors will likely fail in light of an aggregate shock. The pattern that emerges from the data is very close to the mechanism suggested by Calomiris and Kahn (1991) in which the most informed depositors are rewarded for being informed since they can withdraw from failing banks before other depositors do. Note, however, that this interpretation needs to be taken with some caution. While we believe that our evidence supports the interpretation that banks are most informed, we cannot entirely rule out alternative explanations that can be true at the same time.

Importantly, the fact that banks are seemingly well informed about their competitors financial fortunes in the light of the run in turn allows them to provide liquidity to surviving banks via the interbank market: To the extent that banks receive deposit inflows during the run, they continue to intermediate these funds to banks that are subject to deposit outflows. However, banks discriminate between weaker banks that end up failing and stronger banks that end up surviving and only provide liquidity to the latter.

What information do banks have that regular depositors do not have? Unfortunately, we cannot identify *what* exact information banks are acting on. Our findings allow for different possibilities: For instance, banks can have information about a specific bank's solvency, or banks have information about which banks are more likely to fail when other depositors withdraw funds. In either case, however, banks can tell failing banks from surviving banks while regular depositors cannot. Moreover, being able to observe interbank deposit flows allows to predict with a high degree of precision which banks will fail.

7 Additional Results

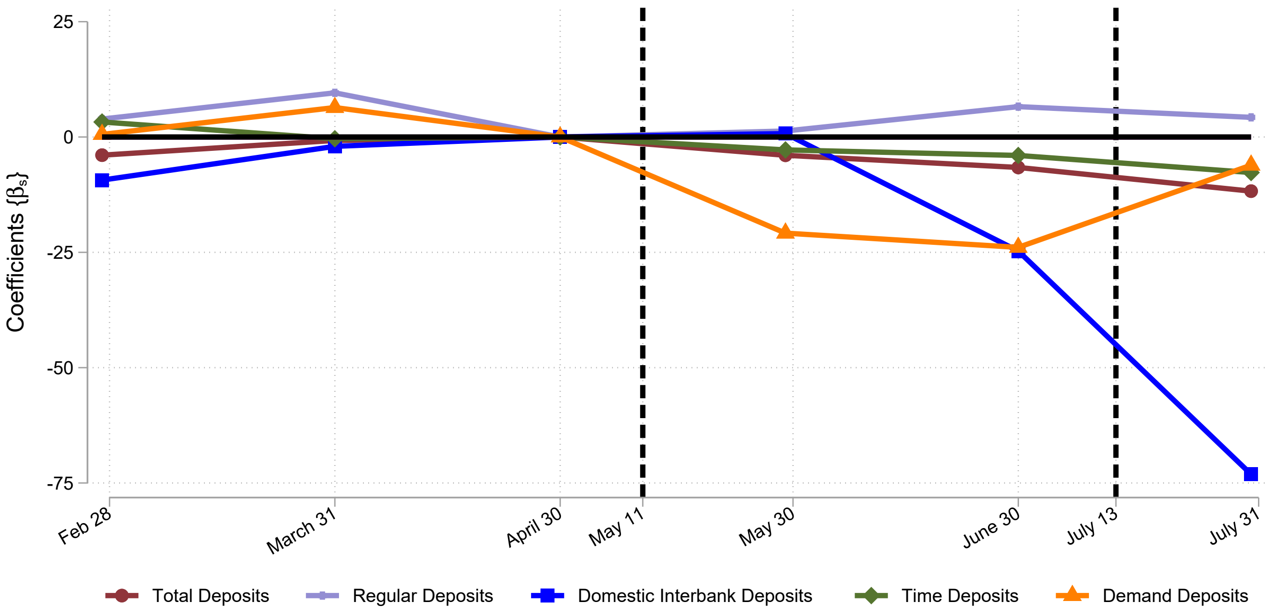
The Role of Foreign-Currency-Denominated Deposits The literature on the German Crisis of 1931 has typically stressed the role of foreign-denominated deposits in the run (see, e.g., Ferguson and Temin, 2003). We next analyze the deposit flow across banks with and without historical reliance on deposits denominated in foreign currency in more detail.

Importantly, the exposure to foreign deposits was not publicly available. Banks only reported their exposure infrequently in confidential filings with the Reichsbank. Figure A.18 in the Appendix shows an example of one such filing. Of course, depositors could have had private information about which banks used foreign-currency-denominated deposits. We can thus ask: are domestic interbank deposits more likely to flow out of banks that rely on foreign deposit funding? If that were the case, to the extent that depositors with foreign currency denominated deposits had stronger incentives to withdraw, it would be another smoking gun indicating that banks are informed about which banks are more likely to be troubled during the run.

In columns (4) of Table 2, we learn that interbank deposits are indeed more likely to flow out of banks that rely on deposit funding. We find that banks with reliance on deposits denominated in a foreign currency see a roughly 64% higher contraction in domestic interbank deposits. Column (10) suggests that these banks also lose around 11% more total deposit funding. Further note that Figure 9 confirms this pattern. Banks that rely on more foreign funding lose interbank funding over time. Note, however, that this is while controlling for whether a bank fails.

The above findings are further a reassuring robustness test as they reveal that all our main findings hold when controlling for the exposure to foreign-currency-denominated deposits. They also support

Figure 9: ***Deposit Dynamics for Banks with Foreign Deposits.***



Notes: The figure displays the sequence of coefficients $\{\beta_s\}$ that results from estimating the model:

$$y_{bt} = \gamma_b + \gamma_{\theta t} + \sum_{s \neq \text{April 31}} \beta_s \times \mathbb{I}[s = t] \times \text{Foreign} + \sum_{s \neq \text{April 31}} \mu_s \times \mathbb{I}[s = t] \times X_b + \epsilon_{bt}.$$

where y_{bt} is the log of one plus the type of deposit indicated in the figure legend for bank b in month t and Foreign_b is an indicator whether a bank relies on foreign deposit funding. We multiply y_{bt} with 100 to convert the coefficients into percentage points. X_b is a set of bank-level control variable. We include a bank's ratio of total liabilities (total assets net of equity) to equity, liquid assets (securities and interbank claims) to total deposits, interbank funding to total deposits, indicators of the size quartile based on total assets, an indicator for use of foreign-currency denominated deposits, and an indicator for whether a bank was connected to the non-financial firm "Nordwolle" that declared bankruptcy in June 1931. All control variables are calculated by averaging at the bank level from February through April 1931. γ_b are bank and $\gamma_{\theta t}$ are bank-type*time fixed effects. The model is estimated using balance sheets reported from February through July 1931 in the *Deutscher Staats- und Preussischer Reichsanzeiger*, dropping banks once they have failed. The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, and corresponds to the failure of Danatbank and the start of the banking holiday.

our main finding on the interbank market having private information on other banks' risks. The exposure to foreign-denominated deposits was not publicly known, but our findings suggest that the interbank market is very well informed about which banks may be subject to withdrawals because they rely on foreign-currency-denominated deposits.

Does the Stock Market Identify Failing Banks? A natural additional test is whether the stock market identifies failing banks. If stock price dynamics reflect the chance of bank failure, the findings that regular deposits are not able to distinguish between failing and surviving banks would of course be even more striking as stock prices are publicly observable and easily available via widely circulated newspapers. Similarly, it is of interest to look at the extent to which stock prices are following or leading the dynamics in the interbank market.

We first study the difference in stock price between failing and surviving banks across time. Note that the sample we can use here is much smaller than our original sample as we only have data for 32 banks in the *Monatskursblatt* of which 28 report balance sheet information and of which only five become distressed and of which only two fail.[35] Hence, the small sample size restricts the ability to make inference. Further, after the breakdown of the banking system on July 13, 1931, the stock exchange was closed and only re-opened in September 1931.

Figure 10 shows the results when estimating Equation (3) for daily stock market data. It reveals that failing and surviving banks' stock were following a quite similar trajectory before the run started. Note that at the first vertical lines, right at the failure of the Creditanstalt, stock prices for failing banks drop by around 5% compared to those that survive. This is an indication that stock market participants realize the importance of the event for the stability of German banks, especially for those banks that are weaker and ultimately fail. However, the difference in the level only turns statistically significant a few days later.

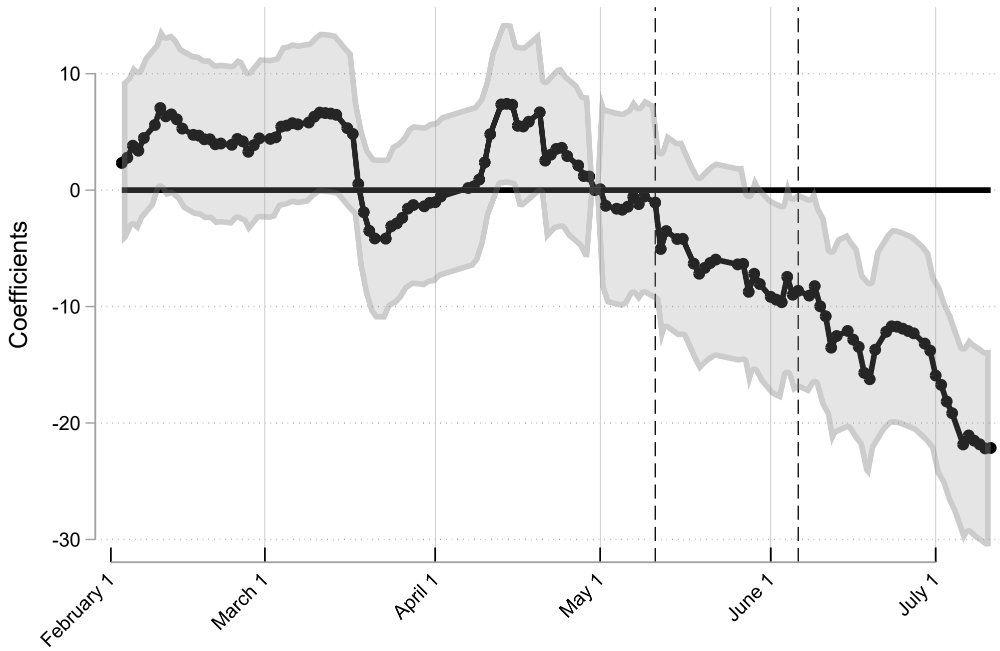
Interestingly, the stock prices for failing banks are already substantially lower (by around 10%) by June 6, when the German government announced the end of reparations. Thus, similarly to the aggregate interbank flows, stock prices start to fall for failing banks early on.

By July 13 when the banking system breaks down entirely and the stock market closes, banks that end up failing have lost around 25% more of their stock market value than those that survive the run. This findings emphasizes how striking our original finding on the behavior of regular depositors is.

[35] The two publicly traded failing banks are the "Danatbank" as well as the "Leipziger Immobilienges. Bk. Grundbesitz A.-G."

Regular depositors are seemingly unable or unwilling to incorporate the information contained in stock prices—which are, as mentioned above, publicly available via newspapers—into their withdrawal decision.

Figure 10: ***Stock Price Dynamics for Failed Banks.***



Notes: This figure plots the sequence of coefficients $\{\beta_s\}$ from estimating a regression of the form

$$y_{bt} = \gamma_b + \gamma_{\theta t} + \sum_{s \neq \text{April 31}} \beta_s \times \mathbb{I}[s = t] \times \text{Failed} + \epsilon_{bt},$$

where y_{bt} is the natural logarithm of the stock price of bank b on day t. γ_b are bank and γ_{thetat} are bank-type* time fixed effects. 95% confidence intervals have been applied. The regressions have been normalized to t=May 1st, 1931.

Next, we test whether interbank flows can be used to predict bank performance in the stock market. To this end, we estimate the following regression:

$$r_{b,t} = \alpha + \beta \times \Delta\text{Interbank}_{bt} + \epsilon_{b,t},$$

where $r_{b,t}$ is bank b's daily risk-adjusted stock market return and $\Delta\text{Interbank}_{bt}$ is the growth of bank b's interbank deposits over the past month. Here, we cluster our estimates at the bank level.

Table 6 reports results. We find no general relationship between past or contemporaneous interbank flows and stock prices, see column (1) in both Panel A and B. Further, studying the effect month by month, we find that outside of the run, interbank flows have no predictive power for stock market prices. For instance, interbank flows in March or April 1931 have no effect on stock price in April or May, respectively; see columns (2) and (3). However, we find that during the first phase of the month,

Table 6: ***Interbank Deposit Flows and Bank Stock Return.***

Dependent variable	Average risk-adjusted daily returns				
Sample period	April - July	April 1931	May 1931	June 1931	July 1931
	Panel A: Interbank Deposit Flows prior month				
	(1)	(2)	(3)	(4)	(5)
Prior Month Interbank	-0.028	-0.139	-0.016	0.088*	-0.129
	(0.062)	(0.279)	(0.078)	(0.046)	(0.169)
N	1635	475	471	477	212
No of Banks	28	25	27	24	24
R^2	.00011	.00099	.000072	.0016	.0038
	Panel B: Interbank Deposit Flows current month				
	(1)	(2)	(3)	(4)	(5)
Interbank	-0.015	0.006	-0.020	-0.058	0.013
	(0.042)	(0.105)	(0.073)	(0.059)	(0.076)
N	1566	475	441	456	194
No of Banks	26	25	25	23	22
R^2	.000039	3.5e-06	.00011	.0007	.000062

Notes: This table reports results from estimating the following model:

$$r_{b,t} = \alpha + \beta \times \Delta\text{Interbank}_{b,t-1} + \epsilon_{b,t},$$

where $r_{b,t}$ is the average of bank b's daily risk-adjusted stock market return over a month. We calculate risk-adjusted return using a one-factor model. $\Delta\text{Interbank}_{t-1}$ is the growth in interbank funding of bank b in the previous or current month. We estimate the model both from April through July (column (1)) and month-by-month (columns (2) through (5)). Standard errors in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

May 1931, banks that lose less interbank funding have abnormally high stock market returns in June 1931, see column (4) in Panel A. However, the same is not true for contemporaneous interbank flows, see column (4) of Panel B. Thus, the interbank market seems to have more information about which banks may fail than the stock market, especially early in the crisis. In the final month of the run, the stock market seems to have incorporated all information and there is again no relation between interbank flows and stock prices, see column (5).

8 Concluding Remarks

In this paper, we exploit the unique historical incident of a run on the entire German banking system during the summer of 1931. Having granular balance-sheet data for commercial banks as well as the central bank, we provide a comprehensive empirical description of the dynamics of the run and establish which types of depositors can discriminate between failing and surviving banks in a bank run.

We find that all banks lose around 20% of their overall deposit funding before the height of the crisis and there is an equal outflow of retail and wholesale deposits from both ex-post failing and surviving banks. Regular depositors are thus unable to identify failing banks. In contrast, the interbank market anticipates which banks will fail. The interbank market collapses for failing banks entirely but it continues to function for surviving banks, which can continue to borrow from other banks in response to deposit outflows (Afonso et al., 2011).

Given that both failing and surviving banks lose the same amount of deposits in the run, it is thus unlikely that the interbank market run causes bank failures (Perignon et al., 2018). However, we cannot tell what banks are informed about. Our findings allow for two possibilities: banks having information about a specific bank's solvency or banks having information about which banks are more likely to fail when other depositors withdraw from them.

Our paper contributes to the broader understanding of the role of short-term debt for financial intermediaries. Our findings highlight the different roles of short-term debt. We argue that some depositors are uninformed and hold short-term debt to obtain liquidity services (Diamond and Dybvig, 1983; Gorton and Pennachi, 1990), while others are informed and able to discipline banks (Calomiris and Kahn, 1991; Diamond and Rajan, 2000, 2001). Specifically, our evidence indicates that interbank depositors are the most informed and are rewarded for being informed since they are the first depositors that withdraw from failing banks, in line with the mechanism in Calomiris and Kahn (1991). However, it is important to highlight that we are not testing the effectiveness of depositor discipline itself. In fact, it is plausible that, rather than disciplining motive, coordination problems may be first order during a financial crisis. Our evidence muted about whether depositors provide discipline in equilibrium.

Our findings also have important policy implications. While one needs to be cautious when generalizing from historical experiences, we believe that the insights on the heterogeneity of depositors is useful empirical evidence when considering the role of interbank markets. The fact that banks can be well informed about which banks will fail in the light of a major financial shock can contribute to the resilience of the interbank market: informed banks subject to deposit inflows can provide liquidity to otherwise healthy banks even during times of severe financial distress. Further, while interbank markets are typically considered to be valuable, as they allow banks to ensure themselves against liquidity shocks (Allen and Gale, 2000), our evidence stresses the informational content of deposit flows and its implications for the functioning of interbank markets. Central bank actions that make interbank markets redundant—such as a reserves regime—may destroy such valuable information.

Further, the fact that information about which banks will fail exists among banks, means that policy makers are in principle able to anticipate the increased risk of crises (Greenwood et al., 2022). For the German crisis of 1931, we find that a policy maker with the ability observe interbank deposit flows could have identified around 50% of all failing banks if willing to accept a false positive rate of 10%. Hence, we find that once a crisis is underway, it may be possible—to the extent an established interbank market exists—to have a sense which institutions are most likely to fail by studying interbank flows.

References

Acharya, V. V. and N. Mora (2015). A crisis of banks as liquidity providers. *Journal of Finance 70*(1), 1–43.

Acharya, V. V., P. Schnabl, and G. Suarez (2013). Securitization without risk transfer. *Journal of Financial Economics 107*(3), 515 – 536.

Adalet, M. (2009). Were Universal Banks More Vulnerable to Banking Failures? Evidence From the 1931 German Banking Crisis. Koç University-TUSIAD Economic Research Forum Working Papers 0911.

Admati, A. and M. Hellwig (2013). Does Debt Discipline Bankers? An Academic Myth About Bank Indebtedness. *Stanford Working Paper No. 3031*.

Afonso, G., A. Kovner, and A. Schoar (2011). Stressed, not frozen: The federal funds market in the financial crisis. *The Journal of Finance 66*(4), 1109–1139.

Allen, F., E. Carletti, and D. Gale (2009). Interbank market liquidity and central bank intervention. *Journal of Monetary Economics 56*(5), 639–652.

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

Anderson, H., G. Richardson, and B. Yang (2023). Deposit insurance and depositor monitoring: Quasi-experimental evidence from the creation of the federal deposit insurance corporation. *Journal of Money, Credit and Banking 55*(2-3), 441–464.

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*.

Balderston, T. (1991). German banking between the wars: The crisis of the credit banks. *Business History Review 65*(3), 554–605.

Balderston, T. (1994). The banks and the gold standard in the german financial crisis of 1931. *Financial History Review 1*(1), 43–68.

Baron, M., E. Verner, and W. Xiong (2020). Banking Crises Without Panics*. *The Quarterly Journal of Economics 136*(1), 51–113.

Born, K. E. (1967). *Die Deutsche Bankenkrise 1931*. Piper & Co. Verlag.

Brunnermeier, M. K. (2009). Deciphering the liquidity and credit crunch 2007-2008. *Journal of Economic Perspectives 23*(1), 77–100.

Brunnermeier, M. K. and M. Oehmke (2013). The maturity rat race. *Journal of Finance 68*(2), 483–521.

Caballero, R. J. and A. Krishnamurthy (2008). Collective risk management in a flight to quality episode. *The Journal of Finance 63*(5), 2195–2230.

Calomiris, C. and G. Gorton (1991). The origins of banking panics: Models, facts, and bank regulation. In *Financial Markets and Financial Crises*, pp. 109–174. National Bureau of Economic Research, Inc.

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 C. M. Kahn (1991). The role of demandable debt in structuring optimal banking arrangements. *American Economic Review 81*(3), 497–513.

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 (2003a). Consequences of bank distress during the great depression. *American Economic Review 93*(3), 937–947.

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

Chodorow-Reich, G., O. Darmouni, S. Luck, and M. Plosser (2022). Bank liquidity provision across the firm size distribution. *Journal of Financial Economics 144*(3), 908–932.

Collet, S. and N. Postel-Vinay (2021). Hot money inflows and bank risk-taking: Germany from the 1920s to the great depression. CEPR Discussion Papers 16606, C.E.P.R. Discussion Papers.

Copeland, A., A. Martin, and M. Walker (2014). Repo runs: Evidence from the tri-party repo market. *Journal of Finance 69*(6), 2343–2380.

Covitz, D., N. Liang, and G. A. Suarez (2013). The evolution of a financial crisis: Collapse of the asset-backed commercial paper market. *Journal of Finance 68*(3), 815–848.

Craig, B. and Y. Ma (2022). Intermediation in the interbank lending market. *Journal of Financial Economics 145*(2, Part A), 179–207.

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 (2000). A theory of bank capital. *The Journal of Finance 55*(6), 2431–2465.

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.

Diamond, D. W. and R. G. Rajan (2005, April). Liquidity Shortages and Banking Crises. *Journal of Finance 60*(2), 615–647.

Diamond, D. W. and R. G. Rajan (2011). Fear of Fire Sales, Illiquidity Seeking, and Credit Freezes *. *The Quarterly Journal of Economics 126*(2), 557–591.

Doerr, S., S. Gissler, J. L. Peydró, and H.-J. Voth (2022). Financial crises and political radicalization: How failing banks paved hitler's path to power. *The Journal of Finance 77*(6), 3339–3372.

Egan, M., A. Hortaçsu, and G. Matvos (2017). Deposit competition and financial fragility: Evidence from the us banking sector. *American Economic Review 107*(1), 169–216.

Eichengreen, B. (1995). *The Gold Standard and the great Depression 1919-1939*. Oxford University Press.

Eisenbach, T. M. (2017). Rollover risk as market discipline: A two-sided inefficiency. *Journal of Financial Economics 126*(2), 252 – 269.

Ferguson, T. and P. Temin (2003). Made in germany: the german currency crisis of july 1931. *Research in Economic History 21*, 1–53.

Foley-Fisher, N., B. Narajabad, and S. Verani (2020). Self-fulfilling runs: Evidence from the us life insurance industry. *Journal of Political Economy 128*(9), 3520–3569.

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.

Galofré-Vilà, G., C. M. Meissner, M. McKee, and D. Stuckler (2021). Austerity and the rise of the nazi party. *The Journal of Economic History 81*(1), 81–113.

Gold, E. A. (1930). Die bankinsolvenzen seit der stabilisierung und ihre ursachen. *Zeitschrift fuer handelswissenscahftliche Forschung* (25), 450–471.

Goldstein, I. (2013). Chapter 36 - empirical literature on financial crises: Fundamentals vs. panic. In G. Caprio, T. Beck, S. Claessens, and S. L. Schmukler (Eds.), *The Evidence and Impact of Financial Globalization*, pp. 523–534. San Diego: Academic Press.

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 G. Pennachi (1990). Financial intermediaries and liquidity creation. *Journal of Finance 45*(1), 49–71.

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

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

He, Z. and A. Manela (2016). Information acquisition in rumor-based bank runs. *Journal of Finance 71*(3), 1113–1158.

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

Ippolito, F., J.-L. Peydró, A. Polo, and E. Sette (2016). Double bank runs and liquidity risk management. *Journal of Financial Economics 122*(1), 135 – 154.

Ivashina, V. and D. Scharfstein (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics 97*(3), 319 – 338. The 2007-8 financial crisis: Lessons from corporate finance.

Iyer, R., T. Lærkholm Jensen, N. Johannesen, and A. Sheridan (2019, 03). The Distortive Effects of Too Big To Fail: Evidence from the Danish Market for Retail Deposits. *The Review of Financial Studies 32*(12), 4653–4695.

Iyer, R., J.-L. Peydro, S. da Rocha-Lopes, and A. Schoar (2014). Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007–2009 crisis. *Review of Financial Studies 27*(1), 347–372.

Iyer, R. and J.-L. Peydró (2011). Interbank Contagion at Work: Evidence from a Natural Experiment. *The Review of Financial Studies 24*(4), 1337–1377.

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.

James, H. (1984). The causes of the german banking crisis of 1931. *Economic History Review 37*(1), 68–87.

Kacperczyk, M. and P. Schnabl (2013). How Safe Are Money Market Funds?*. *Quarterly Journal of Economics 128*(3), 1073–1122.

Karas, A., W. Pyle, and k. Schoors (2013). Deposit insurance, banking crises, and market discipline: Evidence from a natural experiment on deposit flows and rates. *Journal of Money, Credit and Banking 45*(1), 179–200.

Kelly, M. and C. Ó Gráda (2000). Market contagion: Evidence from the panics of 1854 and 1857. *American Economic Review 90*(5), 1110–1124.

Kindleberger, C. P. (1973). *The World in Depression 1929-1939*. London: The Penguin Press.

Kling, C. (2016). Deutscher reichsanzeiger und preußischer staatsanzeiger : Einleitung zur veröffentlichung der digitalausgabe.

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

Liu, X. (2016, 03). Interbank Market Freezes and Creditor Runs. *The Review of Financial Studies 29*(7), 1860–1910.

Luther, H. (1968). *Vor dem Abgrund. Reichsbankprasident in Krisenzeiten. 1930 - 1933*. Propylaen Verlag.

Martin, C., M. Puri, and A. Ufier (2022). Deposit inflows and outflows in failing banks: The role of deposit insurance. *Journal of Finance* (Forthcoming).

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

Morris, S. and H. S. Shin (1998). Unique equilibrium in a model of self-fulfilling currency attacks. *American Economic Review 88*(3), 587–597.

Peria, M. S. M. and S. L. Schmukler (2001). Do depositors punish banks for bad behavior? market discipline, deposit insurance, and banking crises. *Journal of Finance 56*(3), 1029–1051.

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

Ramirez, C. D. and W. Zandbergen (2014). Anatomy of bank contagion: Evidence from helena, montana during the panic of 1893. *GMU Working Paper in Economics No. 13-23*.

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.

Saunders, A. and B. Wilson (1996). Contagious bank runs: Evidence from the 1929–1933 period. *Journal of Financial Intermediation 5*(4), 409 – 423.

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

Schnabel, I. (2004). The german twin crisis of 1931. *The Journal of Economic History 64*(3), 822–871.

Schnabel, I. (2009). The role of liquidity and implicit guarantees in the german twin crisis of 1931. *Journal of International Money and Finance 28*(1), 1 – 25.

Schularick, M. and A. M. Taylor (2012, April). Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870-2008. *American Economic Review 102*(2), 1029–61.

Schumacher, L. (2000). Bank runs and currency run in a system without a safety net: Argentina and the 'tequila' shock. *Journal of Monetary Economics 46*(1), 257 – 277.

Temin, P. (1971). The beginning of the depression in germany. *The Economic History Review 24*(2), 240–248.

Temin, P. (2008). The german crisis of 1931: evidence and tradition. *Cliometrica 2*(1), 5–17.

Tilly, R. H. (1986). German banking, 1850-1914: Development assistance to the strong. *Journal of European Economic History 15*(1).

Ó Gráda, C. and E. N. White (2003). The panics of 1854 and 1857: A view from the emigrant industrial savings bank. *The Journal of Economic History 63*(1), 213–240.