Micro-evidence from a System-wide Financial Meltdown: The German Crisis of 1931

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Micro-evidence from a System-wide Financial Meltdown: The German Crisis of 1931

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Abstract

This paper studies a major financial panic, the run on the German banking system in 1931, to distinguish between banking theories that view depositors as demanders of liquidity and those that view them as providers of discipline. Our empirical approach exploits the fact that the German Crisis of 1931 was system-wide with cross-sectional variation in deposit flows as well as bank distress and took place in absence of a deposit insurance scheme. We find that interbank deposit flows predict subsequent bank distress early on. In contrast, wholesale depositors are more likely to withdraw from distressed banks at later stages of the run and only after the interbank market has started to collapse. Retail deposits are—despite the absence of deposit insurance—largely stable. Our findings emphasize the heterogeneity in depositor roles, with discipline being best provided through the interbank market.

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1 Introduction

Short-term debt makes financial intermediaries inherently fragile and subject to the risk of runs. There are 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, 2001). However, the two types of rationales differ considerably in how they view depositors: While the former tends to view them as liquidity demanders, the latter consider them to be informed providers of discipline. Importantly, policy implications also vary across both types of theories. For instance, a deposit insurance scheme reduces bank fragility under the former but undermines discipline and exacerbates moral hazard according to the latter.

Given the different roles theory assigns to short-term debt, it becomes an important empirical question whether both types of theories prevail empirically? Do different depositors take different roles, with some being informed and able to discipline bank behavior and others being less well informed but valuing bank liquidity provision? To answer these questions, we study the unique historical incident of a run on the entire German banking system during the summer of 1931. Our empirical approach exploits the fact that the German Crisis of 1931 was system-wide with cross-sectional variation in both deposit flows and bank distress and took place in absence of a deposit insurance scheme. First, this allows us to study the extent to which deposit flows can be explained by observable bank characteristics. Second, we investigate whether deposit flows themselves predict future bank distress. The latter in particular allows us to test whether the informational content of deposit flows varies across different types of deposits and across time.

We find evidence that banks are the most informed depositors. Interbank deposit flows are insensitive to publicly observable bank balance sheet characteristics. However, in line with banks having private information about other banks' fragility; interbank deposit flows themselves can predict subsequent bank distress relatively early in the run. In contrast, regular depositors appear less well informed. Their decisions seem based on publicly available and salient information, since regular deposit flows can partly be explained by observable bank characteristics such as capitalization and liquidity. Moreover, deposit flows from regular depositors themselves explain bank distress, but only after interbank deposit flows become informative. Altogether, our findings underline the relevance of heterogeneity among

depositor types during bank runs (Iyer and Puri, 2012; Iyer et al., 2016), with banks being better informed than wholesale depositors which in turn are more informed than retail depositors.

The heterogeneity of depositor behavior has important policy implications. Under the premise that banks are most informed and discipline is best provided through the interbank market, the existence of a functioning interbank market is very valuable. Central bank actions that make interbank markets redundant—such as an abundant reserves regime—may thus be associated with the cost of losing the disciplining function of interbank funding. In contrast, a deposit insurance scheme that targets uninformed demand depositors may not only be ineffective in preventing bank runs, but also have very little potential to undermine the disciplining effect of short-term debt.

We proceed in two steps. In the first step, we provide a comprehensive empirical description of the dynamics of the German Crisis of 1931 and a system-wide run. Having granular balance sheet data for a large set of banks as well as the central bank, we study what types of depositors withdraw first, how banks meet withdrawals, and to what extent deposits leave the banking system. In the second step, we then exploit the cross-sectional variation in bank deposit flows and bank distress and study the informativeness of deposit flows for bank distress.

There are three reasons why the German crisis of 1931 is a close to ideal laboratory to study depositor behavior during a bank run.[1] First, the German central bank (henceforth the "*Reichsbank*") was—due to the political consequences of World War I—legally bound to maintain the Gold Standard and was reluctant to provide support to the banks during the run. Hence, a system-wide bank run played out, which would likely have remained a counterfactual otherwise. Second, the German banking system was generally very lightly regulated, allowing us to study how depositors and banks behave in the absence of deposit insurance, capital regulation, and liquidity requirements. Third, the Reichsbank collected detailed information on bank balance sheets at a monthly frequency, allowing us to track the dynamics of a financial system meltdown at a higher frequency than previous studies.

The run on the German banking system in 1931 took place at the height of the Great Depression in Europe (Kindleberger, 1973). The run started when a major Austrian bank was unexpectedly declared

[1]The theoretical literature has made great progress in understanding the fragility of financial institutions due to maturity and liquidity mismatch (see, e.g., Diamond and Dybvig, 1983; Calomiris and Kahn, 1991; Goldstein and Pauzner, 2005; Kashyap et al., 2017). However, the empirical understanding of system-wide bank runs is—due to the lack of better data—still limited. Since the Great Depression, system-wide banking crises are typically contained by government action at their onset. Empirical research is hence centered around studying runs on individual banks (see, e.g. Iyer and Puri, 2012; Iyer et al., 2016; Martin et al., 2018; Artavanis et al., 2019), using relatively lower frequency data from historical banking crises (see, e.g. Gorton, 1988; Calomiris and Mason, 2003b), or studying financial panics outside the regulated banking sector (see, e.g., Gorton and Metrick, 2012; Krishnamurthy et al., 2014; Copeland et al., 2014; Schmidt et al., 2016).

bankrupt. The bank failure in Austria—which was unrelated to German banks and the German economy—was followed by a strong contraction of deposits in the German banking system. In the first phase of the run, the deposit contraction mostly stems from a decline in interbank lending, met by an equal decline in interbank claims. In the second phase of the run, the collapse of interbank lending is accompanied by an aggregate outflow of wholesale time deposits.

Strikingly, we find that—despite the absence of deposit insurance—demand deposits are stable throughout most of the run. Instead, the run is almost entirely centered on the withdrawal of interbank funding and longer maturity time deposits—the modern day equivalent of wholesale funding. The stability of demand deposits is surprising as standard bank run theories predict that uninsured debt claims with the shortest maturity are most likely to be withdrawn first. The pattern can, however, be rationalized both by maturity shortening in time deposits (Brunnermeier and Oehmke, 2013) as well as by heterogeneity in depositor sophistication and information acquisition (He and Manela, 2016).

Narrative evidence suggests that retail depositors started to withdraw across the board only when a major German bank ("*Darmstädter und Nationalbank*" or "*Danatbank*") declared bankruptcy, marking the third and final phase of the run. The retail depositor run then triggered federal government intervention and the implementation of fiscal measures to contain the crisis. In line with retail depositors reacting slowly, we calculate that the contraction of aggregate deposits is largely accounted for by a contraction of inside money (around 60%) and deposits exchanged into Gold at the Reichsbank (around 30%)—an option not typically easily available for retail depositors. Only few depositors store currency "under the mattress" (around to 10%).

Studying the cross-section of bank stability, we find that there is significant heterogeneity in deposit flows. While some depositors are leaving the banking system entirely, as is typically assumed in models of bank runs (Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005), there is also a considerable degree of deposit reshuffling within the banking system, with some banks even receiving deposit inflows during the run.

In order to identify heterogeneity in depositor information, we first study to which extent different types of deposit flows (interbank vs. regular deposits, demand deposits vs. time deposits) are explained by publicly observable bank characteristics. The balance sheets used in our analysis were published and discussed in detail in newspapers. Thus, they were public information and available to depositors at the time and we can test whether depositor's withdrawal decision are correlated with those observable bank characteristics. In particular, we ask whether different types of depositors are more or less likely

to deposit with better capitalized and more liquid banks during the run.

Second, we exploit that it is ex-post observable which banks become distressed during the run and which banks survive. 19 out of the around 130 banks in our sample become distressed during the run.[2] This allows us to study whether deposit flows themselves correlate with subsequent bank distress across different types of deposits and across time. That is, we test whether the predictive power of variation in deposit flows for bank distress varies across different types of deposits and across different stages of the run. This approach is comparable to a correlation test typically used to identify private information in insurance markets (see, e.g., Chiappori and Salanie, 2000).

An important caveat of our empirical approach is that we cannot identify to what extent withdrawals at an individual bank are primarily caused by the prospect of default or to what extent withdrawals are the primary cause of default. That is, we are not able to distinguish whether a bank is distressed for a fundamental reason or due to its depositors withdrawing for strategic, panic-driven reasons. However, under the assumption that the actions of a single depositor alone cannot induce the default of a given bank, our methodology exploits both cross-sectional and time-series variation of depositor withdrawals and allows us to test whether banks or regular depositors understand which other banks will become distressed.

Our findings reveal that there is significant heterogeneity in the informativeness of deposit flows across different types of deposits and across time. We find that interbank deposit flows are generally insensitive to bank balance sheet characteristics such as bank equity and bank liquidity. However, bank deposit flows themselves are predictive of eventual bank distress after the run has started, in June 1931. This indicates that while banks do not base their immediate withdrawal decisions on information contained in publicly available balance sheets, they seem to have additional private information on which banks are at risk of becoming distressed throughout the run.

Regular customer deposits, in contrast, are sensitive to bank balance sheets characteristics. In line with depositors seeking safety within the banking system, better capitalized and to a lesser extent more liquid banks lose less deposits throughout the run. Further, we also find evidence that regular deposit flows are also able to predict ultimate bank distress. However, regular deposit flows are only correlated with bank distress at the height of the crisis, in July 1931, and are highly correlated with prior interbank deposit flows. Thus, while we find that regular depositors are also able to discriminate between troubled

[2]We define a bank to be distressed if it either defaults, is bailed out, or is subject to a distressed merger during or after the run.

and non-troubled banks, they do so only after banks and our findings indicate that banks are better informed than regular depositors.

Further, when considering the maturity of deposit contracts, we find that banks subject to high *inflows* of demand deposits but high *outflows* of time deposits in the first month of the run are more likely to default. This finding is in line with more informed depositors—among both interbank and regular depositors—shortening maturities in the early phase of the run at banks that are likely to become distressed. Moreover, during June and July 1931 we find that even though demand deposits are increasing on average across all bank, bank-specific outflows of demand deposits are correlated with bank distress. The findings suggest that more informed depositors first shorten maturities in the early phase of the run but then start to withdraw their deposits as the run drags on.

Altogether, our evidence underlines the importance of the heterogeneity of depositor types for depositor behavior during bank runs (Iyer and Puri, 2012; Iyer et al., 2016) with some depositors being more informed than others. Our paper thus contributes to the understanding of the role of short-term debt of financial intermediaries by highlighting the different roles different types of depositors take: banks themselves and to a lesser extent wholesale depositors have information about banks' fragility and can thus provide discipline (Calomiris and Kahn, 1991; Diamond and Rajan, 2001) while retail depositors are less well informed but receive liquidity services (Diamond and Dybvig, 1983; Gorton and Pennachi, 1990).

Our paper proceeds as follows. We review the theoretical and empirical bank run literature in Section 2. Our data sources are described in Section 3. Section 4 provides detailed evidence on the bank run on the German banking system in 1931 before we study the determinants of bank stability and depositor information more rigorously in Section 5.

2 Literature

Our paper contributes to a rich literature on bank runs. 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 explain bank runs either as a consequence of coordination failures or as a consequence of information contagion. For instance, 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.[3] Complementary theories by Chari and Jagannathan (1988) and Jacklin and Bhattacharya (1988) provide models with asymmetric information in which solvency and liquidity shocks cannot be distinguished by all agents, making information-based panics an equilibrium phenomena.

An complementary rationale for the existence of short-term funding of banks and bank runs is provided by Calomiris and Kahn (1991) and Diamond and Rajan (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.[4]

The second generation of models show under which conditions models of self-fulfilling bank runs have a unique equilibrium.[5] Both, 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.[6] Importantly, there exists a range of states of the world in which the bank is fundamentally solvent but nonetheless run upon. These types of runs are then referred to as panic-based runs. This branch of the literature is pushed further by Kashyap et al. (2017) who utilize the concept of unique equilibrium bank run models to discuss optimal banking regulation. Their model allows to derive conditions under which liquidity and capital regulation are means to close the wedge between the competitive equilibrium and the social optimum. In particular, they show that larger liquidity holdings as well as better bank capitalization can lower the probability of bank runs.[7]

Finally, the third generation of bank runs models provide theories of dynamic bank runs. He and

[3]Building on the work by Diamond and Dybvig (1983), a large set of paper analyze bank runs in comparable frameworks. Welfare analysis of bank runs when there is aggregate uncertainty (Allen and Gale, 1998), investment choices when there are sunspot runs (Cooper and Ross, 1998), optimality of demand deposits in case of sunspots (Peck and Shell, 2003), coexistence of financial markets and banking solutions (Green and Lin, 2003), interbank trade where there are local liquidity shocks and contagion (Allen and Gale, 2000), concepts of fire sales (Allen and Gale, 1994), systemic runs (Uhlig, 2010), runs in repo markets (Martin et al., 2014), and discussions of optimal government interventions (Ennis and Keister, 2009) as well as the financial fragility arising form bailouts when governments have limited commitment (Keister, 2015). Further, Gertler and Kiyotaki (2015); Gertler et al. (2017) incorporate bank runs in general equilibrium models, allowing to study how the probability of a bank run taking place feeds back to real economic outcomes, and vice versa.

[4]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.

[5]An early model of unique equilibrium bank runs is provided Postlewaite and Vives (1987).

[6]Unique equilibrium models with self-fulfilling dynamics are also discussed in other contexts such as currency crises (see, e.g., Morris and Shin, 1998).

[7]Liu (2016) models the interplay between trade in the interbank market and creditor runs on financial institutions, revealing that credit crunches of the interbank market can worsen the coordination problems among regular creditors.

Xiong (2012) show that dynamic coordination games, in which rollover decisions are based on anticipated future rollover decisions by other debt-holders, 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 increases the longer the run continues.

While the theoretical literature on system-wide bank runs has made great progress, the empirical study of the subject is typically constrained by the existence of adequate data. Either governments intervene before a system-wide bank run fully plays out, or, when it does occur, data is only available at a low frequency. Therefore, many papers focus on the runs on individual institutions. For instance, Kelly and Ó Gráda (2000) and Ó Gráda and White (2003) study depositor runs using depositor-level data in a New York bank during the Panics of 1854 and 1857. Ó Gráda and White (2003) 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. Shin (2009) provides a case study of the run on Northern Rock's wholesale funding operation.

Crucial empirical evidence on depositor behavior during bank runs is provided by Iyer and Puri (2012) and Iyer et al. (2016), and Martin et al. (2018). Iyer et al. (2016) show that depositors that have stronger ties to the banks, either socially or financially, are less likely to withdraw. Iyer and Puri (2012) provide evidence that sophisticated and uninsured depositors are more sensitive to solvency risk. Martin et al. (2018) show that, prior to bank failures, outflows of uninsured deposits are offset with inflows of insured deposits. Moreover, Artavanis et al. (2019) use deposit-level data from a run on a Greek bank in 2015 and are able to identify to what extent depositors are withdrawing due to concerns about bank solvency and to what extent their behavior is driven by strategic motives and concerns of other depositors withdrawing.

While our data do not allow us to study an individual depositor's behavior in detail, we are able to study the dynamics of the run on an entire banking system. Other papers that have studied system-wide banking panics are largely confined to historical episodes in which data are available at much lower frequency. In a classic study, Gorton (1988) shows that system-wide banking panics during the National Banking Era typically occurred when economic activity peaked. 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.[8]

[8]Calomiris and Mason (2003a) study the real effects associated with the banking crisis. Calomiris and Mason (1997) provide

An important exception 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". Similarly to us, Schumacher (2000) finds evidence that regular customer depositors discriminate between more and less stable banks during the run.

Further, there are several detailed accounts of the run-like phenomena in the shadow banking sector during the 2007-2009 financial crisis (see Brunnermeier, 2009, for an overview). Gorton and Metrick (2012) and Copeland et al. (2014) focus on the collapse in bilateral and tri-party repo during the crisis, respectively. 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.[9] Moreover, further evidence from the 2007-2008 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.[10]

Finally, Egan et al. (2017) provide a structural model of the U.S. banking sector. Estimating the elasticity of deposit supply to bank default risk, they are able to analyze counterfactuals and argue that higher capital requirements can decrease the number of adverse bank run equilibria. Foley-Fisher et al. (2019) propose a structural model to show that a run on U.S. life insurers during the summer of 2007 was in part self-fulfilling. Further, structural models of fire sale dynamics associated with bank runs are provided by Greenwood et al. (2015) and Duarte and Eisenbach (2018).

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. (2017) and Doerr et al. (2018), with the latter focussing on the impact of the failure of the Danatbank on the rise of fascism. Two important accounts of the crisis episode, interpreting it as a banking crisis, are provided by Born (1967) and James (1984). In contrast, Temin (1971, 2008) and Ferguson and Temin (2003) argue that the crisis was largely a currency crisis and not a banking crisis.[11] Schnabel (2004) provides a unifying view, arguing that the crisis was a twin crisis, comprising of a run on the currency as well as the banking system. Moreover, Schnabel (2009)

an account of the bank failures in Chicago during 1932.

[9]Further, Perignon et al. (2018) study short-term, unsecured certificates of deposit in the European market during 2008 to 2014, i.e., during the European Debt Crisis.

[10]This type of phenomena is also discussed in Acharya and Mora (2015) and Ippolito et al. (2016).

[11]Kindleberger (1973) and Eichengreen (1995) emphasize the international dimensions of both, currency and banking crisis.

also studies the effect of liquidity and government guarantees on bank stability during the crisis. For our purposes, we refer to the crisis simply as the "German crisis" rather than a "banking", "currency" or "twin" crisis. While we believe the data do not allow to speak to the causes of the run, we argue they do allow us to study the dynamics of the run and the determinants of bank stability.

3 Data

To conduct our analysis, we hand-collected data from the Federal German Archives ("*Bundesarchiv*") in Berlin and Koblenz. Bank balance sheets were collected by the Reichsbank and made publicly available via newspapers such as the *Berliner Börsenpapiere* and the *Deutscher Staats- und Preussischer Reichsanzeiger*. Bank balance sheets for most major banks are available monthly between 1928 and 1933, excluding balance sheets as of December and January. The data are fairly granular with more than 70 balance sheet items reported. Among other things, the data distinguish between interbank and regular deposits, demand and time deposits, credit lines and terms loans, high and low quality liquid assets, as well as secured and non-secured lending.[12]

Banks that report to the Reichsbank include all the major Berlin banks, government-owned state banks, mortgage banks, and regional credit banks. Further, smaller credit banks publish somewhat infrequently and typically private banks and brokers provide no public information at all. Despite these shortcomings, our data cover more than 50% of the German banking sector's assets and an average of 123 banks per month, containing information on 181 unique banks. In total, our data are comprised of more than 6,000 individual bank balance sheets.

Further, we supplement the balance sheet data of banks with additional filings from the Reichsbank. We hand-collect the weekly balance sheet 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. Further, we also use confidential filings from banks at the Reichsbank that allow us to obtain information on the use of foreign deposit funding. This information is limited to the summers of 1929 and 1930, though it serves as a good indication of which banks hold foreign deposits and make foreign investments. Finally, we use the Reichsbank records to determine which banks fail, which are merged, and which are actively bailed out by the state.[13]

[12]The Appendix provides an example of a reported balance sheet. The data have also been used by, e.g., James (1984), Ferguson and Temin (2003), and Schnabel (2004, 2009).

[13]All Reichsbank data is 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

Finally, we hand-collect data on daily stock prices of from the *Monatskursblatt*, published by the *Berliner Börsenpapiere* for 1931. These are monthly publications that contain daily stock- and bond-price 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 in on the Berlin exchange. We are able to match daily stock prices with balance sheet information from 24 banks covered in the *Reichsanzeiger*.

4 The German Crisis of 1931

We start by providing a description of the dynamics of the system-wide bank run. Next to providing historical context, our data also allow us to revisit a set of classical questions in the bank run literature: What types of depositors withdraw first? How do banks meet withdrawals? What types of assets are liquidated first? To the extent that deposits leave the banking system, where do they go?

The run on the German banking system in 1931 was preceded by a three-year period of output and employment contraction, deflation, and increased political uncertainty. The run started when the failure of the largest Austrian bank, the *Creditanstalt*, was announced on May 11, 1931 (Born, 1967; Kindleberger, 1973; James, 1984). The distress further intensified on June 6 when the German government announced unilaterally that it was unable to continue reparations payments,[14] and finally culminated in the failure of Germany's second largest banks, the Danatbank on July 13.[15] As a consequence of the failure of the Danatbank, the government intervened by declaring a two-day bank holiday followed by a partial suspension of convertibility and the introduction of capital controls.[16] Deposits continued to contract until the end of 1931, albeit at a slower pace. The crisis was considered to be over when the government restructured the largest banks in spring 1932.[17]

German banks were not contractually linked to the Creditanstalt, whose failure had precipitated

"Deutsche Reichsbank": 6479, 6480, 6482, 6484, 6491-2, 6559, 6634, 6709, 6746, 7712.

[14]The announcement ultimately led to the "Hoover Moratorium" on June 20 which paused all war-related debt payments for one year.

[15]The Danatbank had seen a rapid expansion of its balance sheet throughout the 1920's. Among other things, it had lent large amounts to a wool-processing company based in northern Germay, the "*Nordwolle*". The owners of Nordwolle had engaged in fraudulent behavior, which became public information in June 1931, leading to large anticipated losses for the Danatbank.

[16]During July 8-14, 1931, demand depositor runs forced several large and small banks to close and turn to the government for aid. As a consequence, the government imposed a full bank holiday for July 14-15, followed by a partial suspension of convertibility until August 5, 1931. Thereafter, the government partially guaranteed bank liabilities by founding the "*Akzept and Garantiebank AG*" that insured bank default risk.

[17]The failing Danatbank and Dresdner bank were merged and recapitalized by the government. Moreover, the German government claimed one third of the equity of "*Deutsche Bank*"—Germany's largest bank.

the run. The failure of the Creditanstalt is hence 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). Alternative views put more emphasis on the unwillingness of the German government to make reparation payments and interpret the crisis as a currency crisis (Ferguson and Temin, 2003). As mentioned in Section 2, we focus on studying the dynamics of the run and the informational content of deposit flows, but remain agnostic about the causes.

Figure 1a plots the aggregate levels of bank assets, deposits, liquid assets, interbank claims, and loans in the period before, during, and after the crisis. From 1929 to spring 1931, the banking system had been largely stable. While there are two episodes in which deposits and assets fall,[18] there are no larger aggregate trends. However, in the aftermath of the failure of the Creditanstalt, the first vertical line in April of 1931, deposits, interbank lending, and liquid assets all contract strongly. Overall, deposits fall by around 5bn RM between March and November 1931,[19] representing roughly a 25% drop. Notably, the amount of loans outstanding start to enter a period of steady decline when the crisis begins, but do not fall as rapidly.

[FIGURE 1 ABOUT HERE]

Studying the dynamics in more detail, Figure 1b 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 500bn RM from April to May. From May to June as well as from June to July, the aggregate deposit outflow triples to more than 1,500bn RM per month, representing an outflow of around 8% of the pre-crisis level of total deposits for two consecutive months. After July, deposit outflows continue through October, albeit at a somewhat slower pace.

Figure 1b also 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 a by a contraction in interbank lending, which is accompanied by an equal fall in interbank claims. The first month of the run is therefore largely a run of banks on banks. Moreover, note that interbank credit continues to contract steadily throughout the crisis.

[18] The Young plan announcement in fall 1929 led to a first wave of withdrawals from foreign creditors. Moreover, a second wave of withdrawals took place after the German election in September 1930, which saw a rising vote share for non-democratic parties. For both, see James (1984).

[19] Note that during 1931 all balance sheets were reported either as of 28th, 30th or 31st of the respective month.

Between May and June, and again between June and July deposit outflows intensify and in addition to the continuing contraction of interbank deposits, more than 1bn RM of non-interbank deposits are withdrawn from the banking system in each month. Banks meet these withdrawals largely by reducing their holdings of liquid securities. Notably, while aggregate credit is also falling, it contracts much more slowly than the securities portfolio during the bank run itself.

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 3 months. Note though that time deposits could also be withdrawn at any time, although subject to a penalty. Figure 1e shows that the total amount of demand deposits is stable across the crisis period. Hence, the drop in overall deposits is largely driven by an outflow in time deposits. Demand deposits, in contrast, are slightly increasing during the crisis, suggesting that some time deposits are being converted to shorter maturity demand deposits.

The stability of demand deposits throughout the run is a striking finding. Demand deposits are uninsured but remain stable until more than 20% of overall deposits have left the banking system. 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.[20] The pattern can, however, in part be rationalized 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.[21] Indeed, Figure 1f shows that while the average growth of time deposits falls below 10% at the height of the crisis, the average growth rate of demand deposits is positive during June and July 1931.

Time deposits represented an equivalent of modern-day wholesale funding that carried considerably larger interest payments than demand deposits and tended to be held by corporations and wealthy investors. In contrast, demand deposits were more likely to be held by households for transaction purposes. The finding can thus be rationalized by the fact that the latter type of depositor is arguably less sophisticated and less attentive.[22] In particular, large-scale withdrawals of retail depositors only started on July 13, 1931 when the Danatbank closed it branches and the federal government started to

[20] Ferguson and Temin (2003) uses the fact that demand deposits are stable as the key piece of evidence that the crisis is not a banking crisis.

[21] Time deposits could typically be withdrawn or converted at a fee.

[22] Alternatively, 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.

intervene (Born, 1967).[23] However, the run by demand depositors was then contained by a two-day bank holiday and the provision of government guarantees thereafter. Thus, a complementary explanation of the stability of demand deposits is heterogeneity in depositor sophistication and information acquisition (He and Manela, 2016).

This interpretation is in part also supported when we split banks into two groups: those that make extensive use of foreign deposits and those that do not. While both types of banks become subject to the run eventually, early withdrawals are stronger at those banks that rely on foreign funding, see Figure A.2a in the Appendix. Foreign depositors were either large foreign banks or German corporations who used non-RM denominated deposits from abroad for the purpose of tax fraud (see, e.g., James, 1985). Hence, it is plausible that foreign depositors are not only exposed to exchange rate risk in case the Gold Standard would be abandoned, but also generally more attentive and more sophisticated, reinforcing the idea that there is large heterogeneity in withdrawal behavior across different depositor types.[24]

Altogether, the evidence is suggestive that there are three phases of the run. In the first phase, the interbank market shows signs of distress and starts to collapse. In the second phase, the contraction in interbank credit is followed by a dry-up of wholesale funding and arguably better informed and attentive investors withdraw from the banking system. Finally, in the third phase, after the failure of Danatbank, uninsured demand depositors become aware of the crisis and start a full-blown depositor run.

Figure 1b also shows that while outstanding loans contract, they fall by much less than the holdings of securities, even though the drop in lending grows more severe as the crisis drags on. This is intuitive as outstanding loan commitments have long maturities, are not easily traded, and can typically not be called or terminated quickly. Hence, the outstanding loan portfolio can only be reduced gradually by refusing to renew loan contracts. More than that, firms may draw on their committed credit lines (Ivashina and Scharfstein, 2010). In line with this reasoning, the early contraction in credit is relatively sluggish and slow-paced, especially for credit lines, see Figure A.2b in the Appendix. Together with the facts discussed above, this implies that as the run continues overall illiquidity shoots up (Brunnermeier

[23]The pattern of low responsiveness of demand depositors is also evidenced by Ramirez and Zandbergen (2014) who use daily data for a run on four banks in Helena, Montana in the the Panic of 1893.

[24]The figure is thus also in line with the narrative of the crisis that a significant share of time withdrawals are made by foreign depositors (Born, 1967; James, 1984; Ferguson and Temin, 2003; Schnabel, 2004). Moreover, withdrawals at banks with foreign deposits start to slow down after July, in line with the introduction of capital controls. Capital controls were, however, far from complete and foreign withdrawals continued nonetheless throughout the fall as also discussed by James (1984).

and Pedersen, 2008) on the assets side, while on the liability side, the maturities of deposits that remain in the banking system are on average shorter.

Exploiting the cross-section of our data, we further find that even though deposits are leaving the system on aggregate, there is considerable variation across banks. This can be seen by plotting the kernel densities of relative deposit changes across banks in our sample for different points in time in 1931. Figure 1c plots monthly deposit growth from March through July 1931. Just before the bank run starts, the distribution of monthly bank-level deposit growth is centered around zero, with some banks receiving deposit inflows and some being subject to outflows. However, as the crisis progresses, 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, while other banks receive substantial deposit inflows. Further below, we will exploit this variation to identify the determinants of bank stability during the run.

Throughout the spring of 1931, stock prices of publicly listed banks fell: Figure 1d shows the stock prices for the large Berlin banks and the average for a set of smaller regional banks. Stock prices start to decline in April 1931 and continue to fall through July 13, when the stock market was closed. Notably, the stock of the failing Danatbank fell most.

The Reichsbank Our data allow us to also analyze the behavior of the Reichsbank during the crisis. Using information on the Reichsbank's balance sheet, we can infer to what extent banks are liquidating their assets by discounting them at the Reichsbank and to what extent depositors are exchanging their currency for gold. Figure 2a plots the assets and liabilities of the Reichsbank on a weekly basis throughout 1931. During the crisis, the balance sheet expands considerably. On the assets side, we observe a fall in the Reichsbank's Gold reserves from April onwards, in line with depositors exchanging currency into Gold. At the same time, the quantity of discounted paper is continuously increasing. On the liability side, the increase is driven by an increase in "other liabilities" as opposed to an increase in notes in circulation.

Starting in May, the Reichsbank raised its discount rates steeply. It did so in an attempt to stop the outflow of deposits which were being transformed into Gold. The discount rate was raised from 4% at the beginning of the crisis to 15% on August 1 of 1931, see Figure 2c. Moreover, while the Reichsbank was initially willing to lend to banks against various types of collateral, it started to tighten its collateral requirements throughout June and July, reducing rather than increasing the emergency

liquidity provision.

[FIGURE 2 ABOUT HERE]

The Reichsbank's decision to restrict its liquidity provision is related to the legal constraints it was facing. In particular, the Reichsbank was legally bound to cover 40% of its note issuance with Gold reserves.[25] Therefore, rather than increasing the notes in circulation the Reichsbank created other forms of liabilities when discounting assets from commercial banks, a type of emergency note issuance. However, at the height of the crisis, the Reichsbank was unable to meet the coverage ratio and its gold reserves fell behind the minimum requirements starting July 1931, see Figure 2d. Falling short of the coverage ratio coincided with the failure of the Danatbank and the subsequent bank-holiday. At this point the Gold Standard was effectively abandoned and capital controls were introduced.

Our data allow us to further calculate what share of the withdrawn deposits are converted into gold. Figure 2b plots the net outflow in total deposits and outflows of the Reichsbank's gold reserves. We determine that 30% of all bank withdrawals are converted into gold. The remaining contraction in deposits is largely accounted for by a destruction of inside money, i.e., deposit contractions that relates to a fall in interbank lending and credit. We calculate that around 60% of the entire deposit contraction stems from reductions in inside money.

The residual, around 10% is arguably given by deposit withdrawals from the system that are not converted to gold, implying that former depositors start to hold notes instead of deposits and store these "under the mattress". Figure 2b reveals that deposits are more likely to be converted into Gold in the earlier phase of the run. This again emphasized the notion that retail depositors react relatively slowly, as the option to convert notes into gold was typically not easily available for retail depositors.

5 Deposit Flows and Bank Distress

In this section, we study the heterogeneity in bank stability and depositor information in more depth. Specifically, we ask the following two sets of questions: First, what determines both bank distress and deposit flows in the cross-section? Can publicly observable bank characteristics explain which banks

[25] Following the hyperinflation during 1923, the German banking law from August 30, 1924 re-established the Reichsbank as a legal entity entirely independent of the German government, but subject to international supervision. Most importantly, the Reichsbank was required to cover 40% of its note issuance with Gold reserves. Moreover, until 1930, the Reichsbank's governing council that designated the bank's president consisted of 14 member of which 50% had to be foreign.

are more stable? Second, we ask whether variation in deposit flows explain variation in bank distress beyond publicly observable balance sheets? Are interbank deposit flows better in predicting bank distress than the flows of regular deposits? And, is there variation across time? To the extent that there is variation in the predictive power across different types of deposits and time, it would imply that some depositors have information about which banks will become distressed that is not available to all depositors.

Our empirical strategy exploits that, as econometricians, we can observe which banks become distressed throughout the crisis and which banks survive the run. While we have balance sheet information for around 130 unique banks during the phase of the run, 19 of these banks (around 15%) become distressed at some point during the crisis. The cross-sectional variation in both bank distress and deposit flows allows us to test whether some types of depositors are more informed than others by investigating if there is variation in the predictive power of deposit flows across different types of deposits and across time.

An important caveat of our empirical approach is that we cannot identify to what extent withdrawals at an individual bank are caused by the prospect of distress or to what extent withdrawals are the cause of distress. That is, we are not able to distinguish whether a bank is distressed for a fundamental reason or due to its depositors withdrawing. However, our methodology allows us to identify whether different types of depositors anticipate bank distress at different points in time. For instance, we can test whether banks or regular depositors understand which other banks will become distressed—either because they have information about a specific bank's solvency or information about what bank's other depositors will perceive as fragile, or both.

5.1 Empirical specification

We proceed in two steps. First, we explain deposit flows and bank distress independently by bank balance sheet characteristics. Second, we explain variation in bank distress by bank balance sheet characteristics *and* deposit flows. In particular, we test whether the growth of different types of deposits (interbank vs. regular deposits, demand deposits vs. time deposits) have different predictive power for bank distress in different stages of the run.

We start out by studying the variation in bank distress and deposit flows independently. On the one hand, this allows us to test whether distressed banks are different than non-distressed banks prior to the run in their observable characteristics. On the other hand, it allows us to test whether deposit flows are

sensitive to balance sheet information. Recall that the balance sheets used in our analysis were published in the *Reichsanzeiger* with a one month lag and were often discussed in detail in newspapers. Thus, they were public information and available to depositors at the time. We can test whether depositors withdrawal decision are correlated with those observable bank characteristics.

In both analyses, our empirical approach is guided by predictions derived from theoretical models of bank runs. Canonical bank run theories predict that, ceteris paribus, banks that are better capitalized and banks that have a lower degree of liquidity and maturity mismatch have a higher distance to default and are less likely to be subject to a run (see, e.g., Rochet and Vives, 2004). Moreover, while both reduce run risk ex-ante, bank equity is predicted to be particularly effective in increasing bank stability when default is likely to arise due to fundamental risk. In contrast, holding relatively more liquid assets can increase bank stability when bank runs are more likely to stem from strategic motives or when panic-based runs are more likely (see, e.g., Kashyap et al., 2017).

In the first step, we test whether bank balance sheet characteristics predict bank distress during the crisis and investigate whether better capitalized and more liquid banks are more or less likely to become distressed. We estimate the following simple cross-sectional model:

$$\Pr[\text{Distress}_b] = \beta_1 \times \text{Equity}_b + \beta_2 \times \text{Liquidity}_b + \rho X_b + \gamma_\theta + \epsilon_b \tag{1}$$

where Distress_b is a dummy that takes the value one if bank b becomes distressed between May 1931 and August 1932. We define a bank as becoming distressed if it either goes out of business, becomes subject to a distressed merger, or is bailed out and restructured during or after the crisis, i.e., between May 1931 and August 1932. Table 1 provides a comprehensive list of the distressed banks. The list includes for instance the early failures of *Landesbank der Rheinprovinz*, *Danatbank* and *Dresdner Bank* in June and July 1931 but also the restructuring of *Deutsche Bank* in early 1932. Note, that we exclude any bank from our estimation sample once it has become distressed.

[TABLE 1 ABOUT HERE]

Equity_b and Liquidity_b denote bank b's capitalization and liquidity at the onset of the bank run, respectively.[26] We measure a bank's capitalization by using the ratio of bank capital over total bank credit, and a banks liquidity by the ratio of liquid assets relative to total assets. We choose to calculate

[26] We measure these variables as the average between September 1929 and September 1930.

the former as a share of total credit and the latter as a share of total assets to avoid a mechanical correlation of the two. Further note that the results are largely robust to variations in the definition of bank capitalization and liquidity. Moreover, we include a set of other control variables such as the bank's size measured by natural logarithm of a banks assets, the ratio of foreign deposits over total deposits,[27] and the share of interbank and demand deposits as of total deposits. Finally, we also include bank-type fixed effects, γ_θ to account for the differences in bank business models across the different types of banks (Berlin banks, mortgage banks, regional banks, Landesbanken, Girozentralen) which in turn may affect the likelihood of distress and government interventions.

Next, we study the cross-section of deposit flows. Unlike bank distress, which is time invariant, deposit flows vary throughout the run and thus allow us to estimate a panel regression. Specifically, we estimate:

$$\begin{aligned}\Delta\%D_{b,t} =& \tau_t + \beta_1 \times \text{Equity}_b \times \text{May 1931}_t + \beta_2 \times \text{Liquidity}_b \times \text{May 1931}_t \\ &+ \rho \times X_b \times \text{May 1931}_t + \gamma_b + \epsilon_{b,t}\end{aligned} \tag{2}$$

where $\Delta\%D_{b,t}$ is the monthly growth rate of deposits from $t-1$ to t, and we distinguish between the growth in different types of deposits, including total deposits, interbank deposits, regular deposits, time deposits, and demand deposits.[28] This allows us to test whether different types of deposits are more or less responsive to observable balance sheet characteristics. Further, we include time fixed effects τ_t and X_b is as above a set of control variables. May 1931_t is a dummy that takes the value of one after the Austrian Creditanstalt has failed, i.e., from May 1931 onwards. Here, we also include a set of bank fixed effects γ_b.

Finally, after studying the correlation of deposit flows and bank distress with bank balance sheets characteristics independently, we study them jointly by regressing bank distress on deposit flows themselves while controlling for bank characteristics. This allows us to link bank distress and deposit flows and understand whether there is informational content in deposit flows beyond the publicly available information contained in bank balance sheets. That is, we estimate the following model month-by-month:

[27] Foreign funding is not an item reported in the monthly balance sheets. Instead, we use confidential filings at the Reichsbank that summarizes foreign exposure by banks as of June 1929 and June 1930.

[28] Our data allow us to decompose total deposits into interbank and customer deposits. Moreover, for a subset, we can decompose total deposits into time and demand deposits. We do not have information on the share of time and demand deposits within the categories of interbank and customer deposits.

$$\Pr[\text{Distress}_b] = \alpha + \beta \times \Delta\%D_b + \rho \times X_b + \epsilon_b, \tag{3}$$

where Distress_c is as in Equation (1) an indicator for bank distress and $\Delta\%D_b$ is as above the monthly growth rate in deposits.

Here, our analysis is thus comparable to a correlation test (see, e.g., Chiappori and Salanie, 2000) that allows us to study whether variation in deposit growth explains bank distress. In particular, testing whether the predictive power varies across different types of deposits (interbank vs. regular deposits, demand deposits vs. time deposits) and different stages of the run allows us to study whether depositor types differ in their ability to discriminate between stable and fragile banks.

As mentioned above, an important caveat is that we cannot identify whether withdrawal motives are based on the prospect default or the cause of default. However, in this third step of our analysis, we are nonetheless able to identify heterogeneity in depositor information: Under the assumption that no single depositor's action can trigger bank distress, variation in the predictive power of deposit flows across different types of deposits and time is evidence on heterogeneity of depositors' information. I.e., some depositors are better in anticipating which banks will become distressed—either because the bank would have become distressed even in absence of withdrawals (fundamental distress) or due to the withdrawals (panic-based distress).

5.2 The cross-section of bank distress and deposit flows

We start out by presenting our findings on the cross-section of bank distress and deposit flows. As described above, German banks were not subject to capital or reserve requirements. Hence, capital and liquidity ratios can be freely chosen and are only subject to market constraints. For instance, banks with riskier assets choose to issue more equity. Likewise, banks with more fragile deposit funding may choose to hold more liquid assets. Moreover, and perhaps more concerning, banks may increase their capitalization and liquidity holdings in anticipation of the bank run. Thus, bank capitalization and liquidity holdings are endogenous. We thus do not interpret our coefficients as the causal effect of additional equity or liquidity. Rather, we test whether publicly available information on bank characteristics at the time explain the cross-section of bank stability during the bank run.

We start out by estimating Equation (1). The results are reported in Table 2. Columns (1) and (2)

report OLS estimates, (3) and (4) report Probit estimates. Further, columns (1) and (3) report results excluding bank-type fixed effects and columns (2) and (4) include them. Altogether, the results reveal that there is some weak indication but no conclusive evidence that both better capitalized and more liquid banks are less likely to default.

Excluding bank-type fixed effects, our estimation results show that there is no indication that better capitalized and more liquid bank are more or less likely to become distressed. The specification that includes bank-type fixed effects, however, indicates a somewhat more meaningful relationship. For instance, columns (2) and (4) reveal that a one standard deviation increase in the equity-to-loans ratio reduces the probability of bank distress by 1.5-4 percentage points. Similarly, a one standard deviation increase in the liquidity ratio decreases the chance of distress by around 6-12 percentage points. However, the effect is not statistically significant in either of the estimations.

[TABLE 2 ABOUT HERE]

Next, we estimate Equation (2), now using monthly deposit growth as the dependent variable. Column (1) shows that banks with more equity and lower liquidity mismatch prior to the bank run experience lower total deposit outflows during the crisis. While the average monthly outflow is 2.4 percentage points between October 1930 and November 1931, we estimate that a bank with a one standard deviation higher capital ratio can expect, all else equal, to experience a 1 percentage points lower deposit outflow on average after the run starts in May 1931. Moreover, banks that have a one standard deviation higher liquidity ratio experience a 1.5 percentage point lower monthly outflow of deposits after the failure of the Creditanstalt. The effects are hence both economically and statistically significant.

[TABLE 3 ABOUT HERE]

We next estimate Equation (2) distinguishing between the growth in interbank deposits and regular deposits. The average monthly contraction in interbank deposits and regular customer deposits is 3.7 and 1.8 percentage points, respectively, between October 1930 and November 1931. Further, studying the cross-section, column (2) of Table 3 shows that interbank deposits flows are not sensitive to a bank's equity position, but column (3) shows that customer deposit flows are. Said differently, we find that regular deposits are more stable during the bank run when bank equity and bank liquidity

is higher—although the effect of the latter is somewhat weaker. This indicates that regular depositors when seeking safety within the banking system, seem to perceive banks with more equity and liquidity as safer. In contrast, banks themselves seem to make their interbank lending independent of a bank's capital or liquidity position, possibly reflecting that banks have additional private information on other banks' conditions.

We then estimate Equation (2) using the monthly time and demand deposit growth as the dependent variables. Results are shown in Column (4) and (5) of Table 3. Recall that the deposit outflows mostly stem from an outflow in time deposits as the run is largely taking place in the wholesale funding market. In line with this, the average outflow in time deposits are much higher than the average outflow in total deposits or demand deposits: time deposits decrease on average by 3.2 percentage points per month throughout the sample period, while demand deposits only contract by 1.8 percentage points.

As with total deposit growth, bank capitalization and bank liquidity predict lower outflows for time deposits. While a one standard deviation increase in bank capitalization decreases the deposit outflow during the crisis by around 0.65 percentage points, a one standard deviation increase in bank liquidity decreases outflow by around 1.4 percentage points. As with total deposits, the effect of bank liquidity is somewhat stronger in magnitude than the effect of bank liquidity.

However, while there is a relationship between bank capitalization, liquidity and time deposit flows, there is no such systematic relationship for demand deposits. Thus, the flow of demand deposits is largely unexplained by the observable bank characteristics. Unfortunately, our data do not allows us to determine what share of demand deposits are interbank deposits and what share is held by retail depositors. Thus, the finding is either driven by the fact that interbank deposit flows are unrelated to observable bank characteristics or due to the fact that retail depositors are inattentive, or both.

Altogether, the evidence suggests that both bank capitalization and bank liquidity predict bank stability measured by deposit outflows of regular customer deposits and time deposits. Hence, our findings are in line with wholesale depositors paying attention to hard information when seeking safety within the banking system. Interbank deposits, in contrast, are seemingly independent of publicly observable balance sheet characteristics, given access to private information.

5.3 Informational content of deposit flows

After using balance sheet characteristics to explain both bank distress and bank deposit flows independently, we next study how both relate to each other to identify whether depositors discriminate between

troubled and non-troubled banks *beyond* making use of publicly observable bank characteristics. Our findings here reveal that there is large heterogeneity in the informativeness of deposit flows for different types of deposits and across time.

We first estimate Equation (3) studying the relationship of bank distress and interbank and regular deposit. Starting with interbank deposit flows, the upper panel of Table 4 and panel (a) of Figure 3 reveals that interbank deposit flows are not predicting bank distress outside of the crisis, i.e., in either November 1930, March 1931, or April 1931. However, after the run has started, a higher outflow of interbank deposits in June 1931 is associated with a higher chance of becoming distressed throughout the run. In particular, a one standard deviation increase in deposit inflows in June implies a 6 percentage points lower chance of becoming distressed throughout the run. The effect is economically sizable and statistically significant.

Note though, that interbank deposits already start to contract in the aggregate during May 1931. Thus, we find that interbank deposit flows are only correlated with eventual bank distress after the collapse of the interbank market has already started. This suggests that banks are taking a generally more cautious position during May 1931, although without yet discriminating between banks that end up becoming distressed or not. Banks start to discriminate between fragile and stable banks only in June 1931 when other types of depositors also started to withdraw.

[FIGURE 3 AND TABLE 4 ABOUT HERE]

Importantly, we find that other depositors are also able to discriminate between troubled and non-troubled banks. The lower panel of Table 4 and panel (b) of Figure 3 shows results on the relation of regular deposit flows and bank distress. As with interbank deposit flow, regular deposit flows are not indicative of bank distress in the months prior to the run, see columns (1)-(3) of panel (b). Further, they are also not prediciting bank distress during the first two month of the run, see column (4) and (5) of panel (b). However, flows of regular deposits become predictive of bank distress during the height of the run in July 1931, see column (6) of panel (b). In particular, a one standard deviation increase in deposit outflows during July 1931 implies an around 4 percentage point higher chance of becoming distressed. Thus, non-bank depositors are able to distinguish weaker banks from stronger bank, but only in the later stages of the run, following the lead of the interbank market.[29]

[29] As discussed in Section 4, the fact that most deposits being withdrawn during June and July 1931 are time deposits as well as narrative evidence (see, e.g., Born, 1967) suggests that retail depositors only start to withdraw after the failure of Danatbank

Figure A.5 shows that regular deposit flows are largely uncorrelated with past growth in interbank deposit for April through June 1931. Moreover, there is no difference across banks that end up becoming distressed and those that survive. However, in July 1931, regular deposit flows become correlated with interbank deposit flows in June 1931, and the correlation is most pronounced in those banks that end up becoming distressed. This findings suggests that regular depositors observe interbank flows and update their assessment of bank stability accordingly. A complementary explanation is that the freeze of the interbank market itself may also worsen the coordination among regular bank depositors (see, e.g., Liu, 2016).

We next exploit that our data allows us to distinguish between demand deposits and time deposits. When considering the maturity of deposit contracts, estimates from Table 5 and panel (c) and (d) of Figure 3 reveal three important findings.

First, we find that banks subject to high *inflows* of demand deposits in the first month of the run, May 1931, are more likely to be become distressed, see column (4) of Panel (a) in Table 5. This finding, albeit unintuitive at first glance, is in line with informed depositors taking a more cautious stance in the early phase of the run and shortening maturities (Brunnermeier and Oehmke, 2013) at banks that are likely to become distressed. In particular, note that the the inflow of demand deposits is mirrored by an outflow in time deposits which could be withdrawn or converted into demand deposits at a fee. A higher outflow in time deposits in turn is associated higher chance of bank distress. Unfortunately, as described above, our data do not allow us to distinguish whether the maturity shortening is done within the interbank market or done be regular deposits.

Second, we find that as the run continues through June and July 1931, a relatively larger *outflow* of demand deposits becomes associated with a higher chance of bank distress, see columns (5) and (6) of panel (a) of Table 5. This finding is interesting in light of the fact that, in the aggregate, the contraction of deposits is largely stemming from a contraction in time deposits. Demand deposits rather increase throughout the run. Recall the evidence presented in Figure 1f that shows that the average bank experiences a positive growth of demand deposits throughout June and July 1931 (i.e. the height of the crisis). At the same time though, we find that banks which end up becoming distressed lose relatively more demand deposits at this time. This finding can be reconciled with informed depositors first converting time deposits into demand deposits in the early stage of the run at fragile banks, and

on July 11, 1931 and the subsequent start of government containment actions. Thus, most withdrawals documented in our data during this period are likely withdrawals from relatively better informed wholesale depositors. Thus, it is not surprising to find that the deposit flows are predictive of bank distress.

withdrawing them at the height of the crisis.

Third, time deposits outflows are generally not predictive of bank distress after the maturity shortening in May 1931. Despite most outflows resulting from a contraction in time deposits in June and July 1931, time deposit flows become entirely uninformative, indicating that many depositors are not discriminating between banks' fundamentals and withdrawing from all banks equally—irrespective of the whether a bank is ultimately distressed or not. Thus, this finding is in line with some wholesale funding depositors conducting panic-based withdrawals and seeking safety outside of the banking system.

[TABLE 5 ABOUT HERE]

Altogether, our findings thus suggests that banks have the most information about the state of the banking system and are the most sophisticated type of depositors. In particular, banks anticipate which banks become distressed prior to other depositors. Moreover, bank deposit flows cannot be explained by observable bank characteristics, indicating that banks withdrawal decisions throughout the run are governed by private information. In contrast, regular depositors only distinguish between fragile and stable banks at the height of the crisis and their deposit flows are in part explained by observable public information. Thus, our evidence suggests that banks are arguably better positioned to discipline other banks (Calomiris and Kahn, 1991; Diamond and Rajan, 2001).

6 Discussion

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 and the central bank, we provide a comprehensive empirical description of the dynamics of the run. Our evidence suggests that depositor information plays an important role for the dynamics of the run. The run can be broadly categorized into three phases. In the first phase, banks start to run on each other and the interbank market collapses. In the second phase, wholesale funding dries up when arguably more informed and attentive non-bank investors start to withdraw from the banking system. Finally, in the third phase, when a major bank fails, uninsured but arguably inattentive demand depositors become aware of the crisis and start a full-blown depositor run, triggering government intervention.

Exploiting the cross-sectional variation in both deposit flows and bank distress, we are able to

identify heterogeneity in bank stability and depositor behavior as crucial determinants of the dynamics of a system-wide financial panic. We provide evidence that depositors discriminate between troubled and non-troubled banks, but there is also large variation in depositor information. We identify depositor information by testing whether unexplained variation in deposit flows during the run predicts bank distress. We find that interbank deposit flows predict subsequent bank distress in the early phase of the run, in line with banks being most sophisticated and best informed about the state of the banking system. In contrast, regular depositors discriminate between stable and fragile banks only at later and only after the interbank market has started to collapse.

Our paper contributes to the understanding of the role of short-term debt of financial intermediaries. Our findings highlights the different roles of short-term debt. In particular, 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, 2001). Specifically, our evidence indicates that interbank and wholesale funding are most informed and can thus provide discipline while demand depositors are less well informed and tend to be demanders of liquidity services.

The heterogeneity of depositors and their different roles has important policy implications. Under the assumption that most discipline is provided through the interbank market, the existence of a functioning interbank market can thus be very valuable. Central bank actions that make interbank markets redundant—such as an reserves regime—may thus be associated with the cost of losing the disciplining function of short-term debt. In contrast, deposit insurance that targets uninformed demand depositors should thus have very little potential to undermine the disciplining effect of short-term debt as such depositors are unlikely to provide discipline to begin with.

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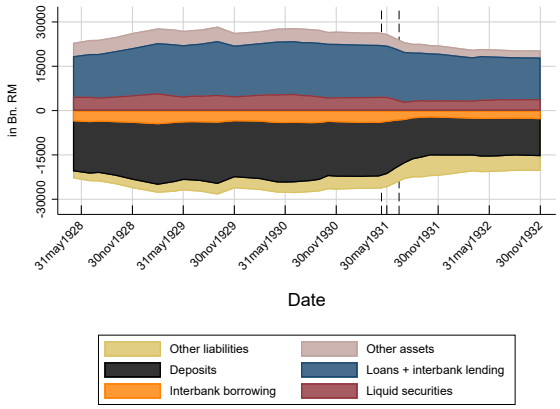
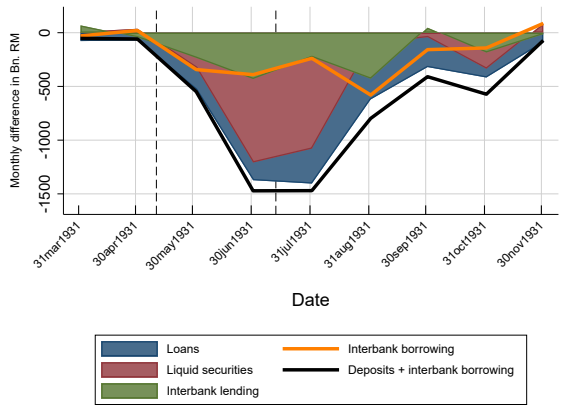
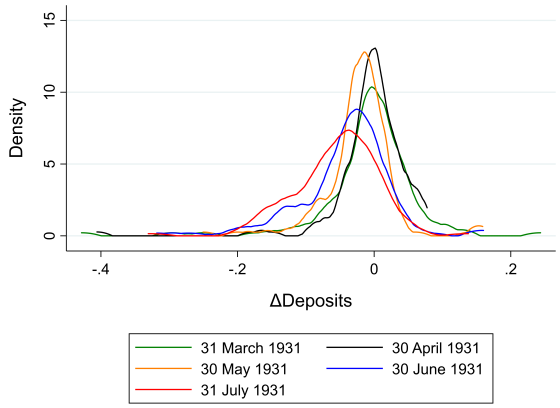
7 Figures



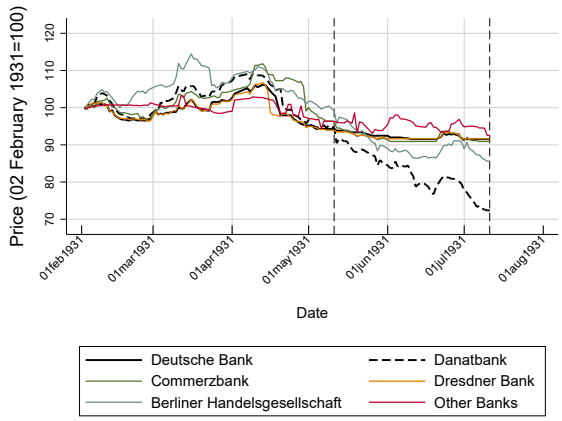
(a) *Aggregate levels of bank assets, deposits, loans, interbank lending, and liquid securities (cash, treasury bills, corporate securities) on a monthly basis from April 1928 to November 1932.*



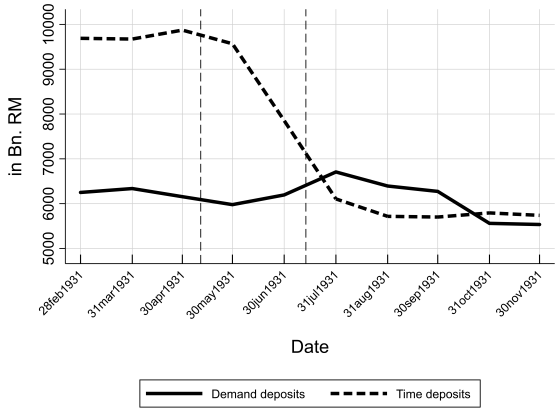
(b) *Month-to-month differences in aggregate bank deposits, interbank lending, interbank borrowing, securities holdings, and bank loans between March 1931 and November 1931.*



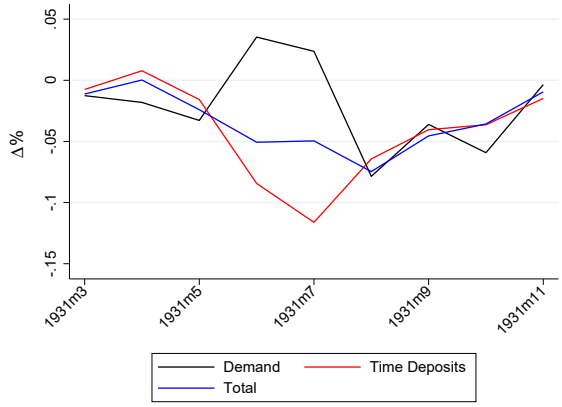
(c) *Density of monthly bank-level deposit growth rates from March 1931 to July 1931.*



(d) *Stock prices for 5 large Berlin banks and other regional banks.*

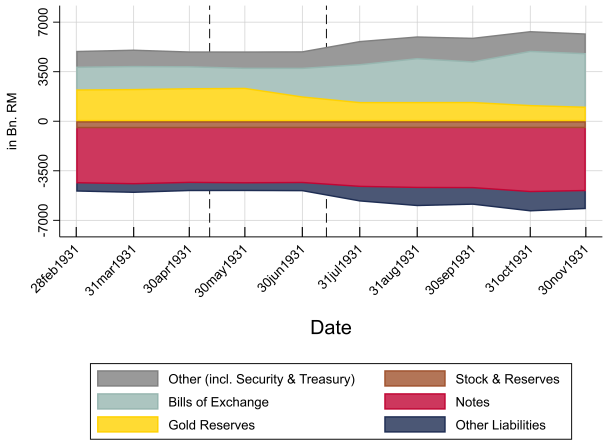


(e) *Aggregate levels of time and demand deposits between February 1931 and November 1931.*

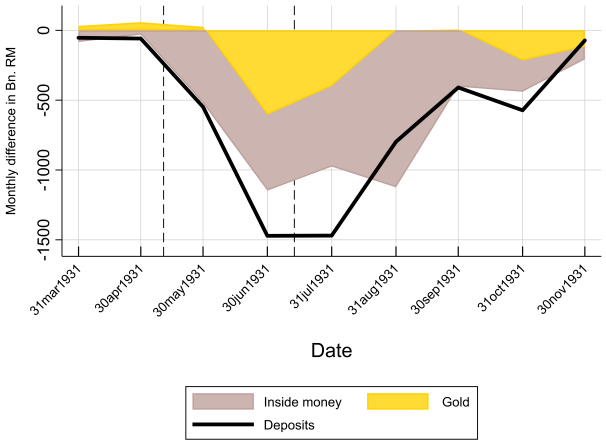


(f) *Average change in regular, time, and demand deposits.*

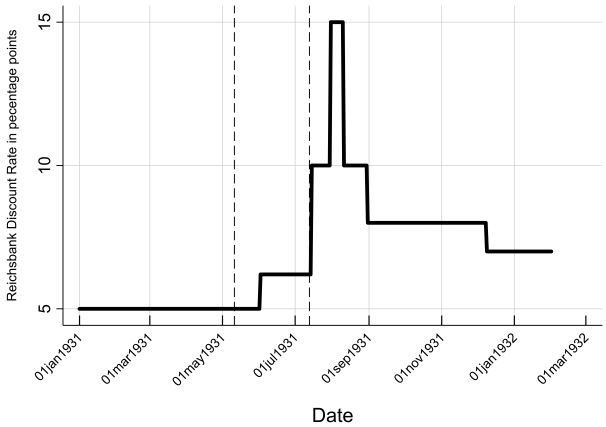
Figure 1: ***Aggregate dynamics I.*** *The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, and corresponds to the failure of the German Danatbank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January.*



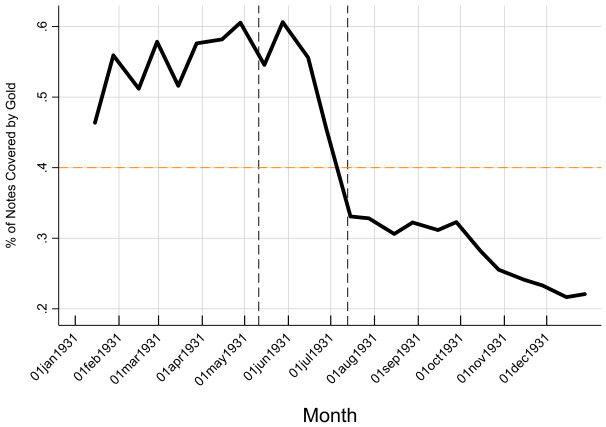
(a) *Evolution of the Reichsbank's assets and liabilities at a weekly frequency from January 1931 through December 1931.*



(b) *Month-to-month differences in aggregate deposits, gold reserves held by the Reichsbank, and inside money (interbank borrowing and credit) between March 1931 and November 1931.*

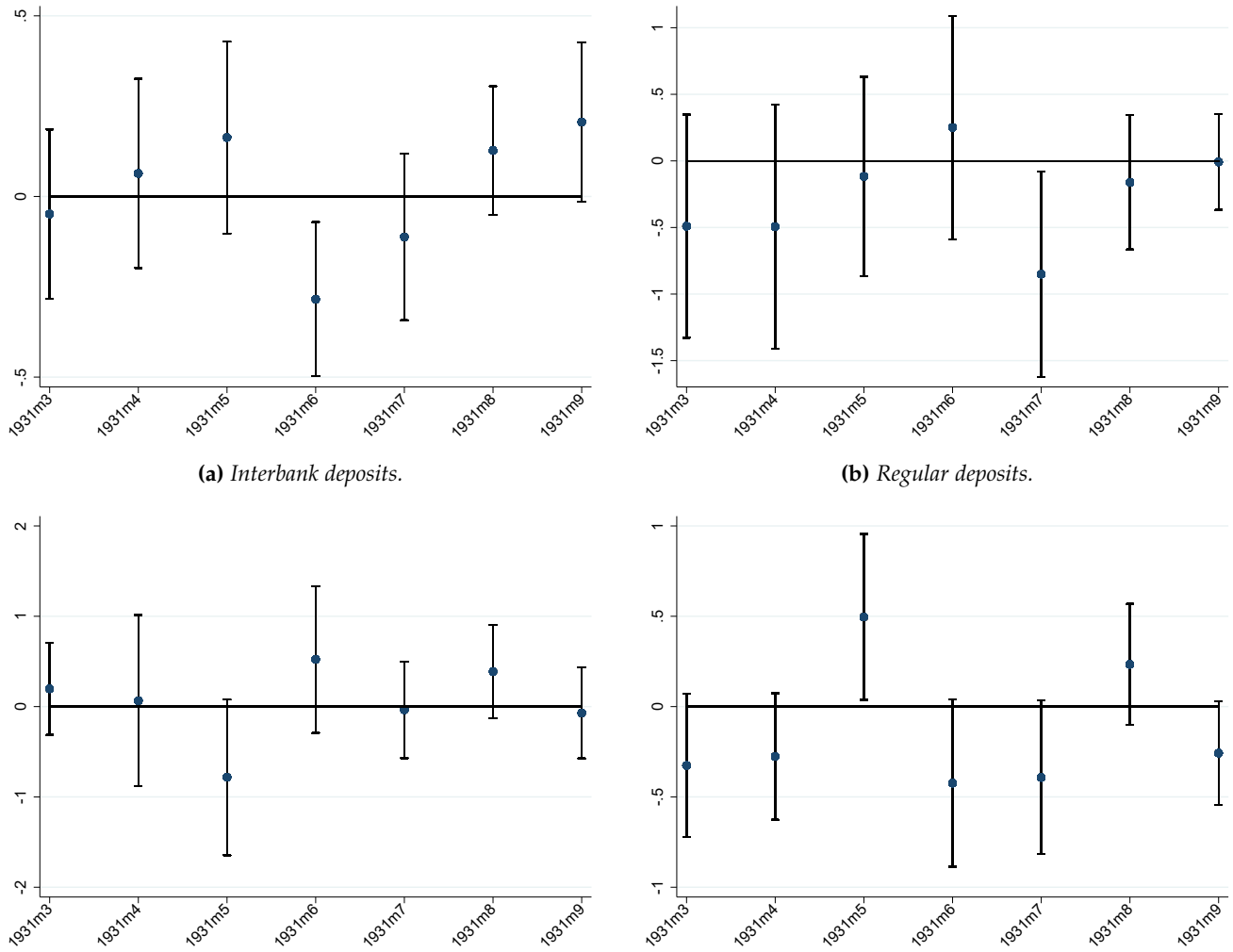


(c) *Reichsbank Discount rate between October 1929 and January 1932.*



(d) *Ratio of outstanding notes relative to Reichsbank gold reserves. Horizontal line marks the 40% minimum gold coverage ratio.*

Figure 2: ***Reichsbank during the crisis*** *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, corresponds to the failure of the German Danatbank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January, Reichsbank balance sheet data is available at a weekly frequency, and the discount rate is available at a daily frequency.*



(a) *Interbank deposits.*

(b) *Regular deposits.*

(c) *Time deposits.*

(d) *Demand deposits.*

Figure 3: ***Informational content of deposit flows.*** *Notes: This figure reports results from estimating Equation* (1) *month-by-month from November 1931 through September 1931. We only keep banks in the estimation sample before they become distressed and exclude them as of the month of the distress event. 95% confidence intervals.*

8 Tables

Table 1: *List of distressed banks*

Bank	Event Date	Event
Landesbank d. Rheinprovinz	June 1931	Bail out
Gewerbebank AG	June 1931	Distressed merger
Allgem. Deutsche Kredit-Anstalt	July 1931	Bail out
Darmstaedter und Nationalbank	July 1931	Distressed merger
Dresdner Bank	July 1931	Bail out
Hallescher Bankverein v. Lullisch, Kaempf u. Co., K. a. A.	August 1931	Bail out
Bank fuer Handel und Gewerbe	September 1931	Default
Leipziger Immobilienges. Bk. Grundbesitz A.-G.	September 1931	Default
Leipziger Kredit-Bank	September 1931	Bail out
Rheinische Bauernbank A.-G.	October 1931	Bail out
Hollandische Kreditbank AG	October 1931	Default
Vorschuss- u. Spar-Vereins-Bk. In Luebeck	November 1931	Default
Anhalt-Dessauische Landesbank	December 1931	Distressed merger
Commerz-Bank in Luebeck	December 1931	Bail out
Wernigeroeder Bank	February 1932	Default
Deutsche Bank	February 1932	Bail out
Staedte u. Staatsbank d. Oberlausitz K. a. A.	June 1932	Default
Bernburger Bank	July 1932	Default
Westfalenbank A.-G.	August 1932	Bail out

This table lists the major banks that failed, bailed out, or merged by government intervention between June 1931 and August 1932.

Table 2: ***Bank distress in the cross-section.***

Dependent variable	Distress			
Estimation	OLS		Probit	
	(1)	(2)	(3)	(4)
Equity	0.017	-0.033	0.024	-0.095
	(0.039)	(0.037)	(0.065)	(0.077)
Size	0.258	0.210	0.511	0.404
	(0.211)	(0.194)	(0.372)	(0.358)
Liquidity	-0.202	-0.287	-0.495	-0.703
	(0.190)	(0.186)	(0.421)	(0.452)
Foreign Deposits	-0.093	-0.427**	-0.291	-0.994**
	(0.147)	(0.192)	(0.270)	(0.426)
Mean	.086	.086	.086	.099
R^2	.071	.15		
N	128	128	128	111
No of Banks	128	128	128	111
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
BankType FE	No	Yes	No	Yes
Bank FE	No	No	No	No
BankType-Time FE	No	No	No	No

This table reports results from estimating

$$\begin{aligned}\text{Distress}_b = &+ \beta_1 \times \text{Equity}_b + \beta_2 \times \text{Liquidity}_b \\ &+ \beta_3 \times \text{Size}_b + \beta_4 \times \text{Foreign Deposits}_b + \gamma_\theta + \epsilon_b,\end{aligned}$$

where Distress_b is dummy variable indicating whether the respective bank becomes distressed between June 1931 and August 1932. The model is estimated using the cross-section of banks for which we have data in March 1931. Robust standard errors are clustered at the bank level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 3: ***Deposit flows in the cross-section*** — *Data from October 1930 and March 1932.*

Dependent variable	Δ%Deposits	Δ%Inter	Δ%Cust	Δ%Time	Δ%Demand
	(1)	(2)	(3)	(4)	(5)
Equity× May 1931	0.033***	-0.018	0.020***	0.034***	0.009
	(0.006)	(0.026)	(0.007)	(0.007)	(0.007)
Liquidity × May 1931	0.110***	0.134	0.042	0.108**	0.069
	(0.035)	(0.110)	(0.035)	(0.051)	(0.061)
Mean	-.026	-.037	-.018	-.032	-.019
R^2	.26	.1	.16	.24	.13
N	1389	1389	1389	1389	1389
No of Banks	126	126	126	126	126
Controls	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
BankType FE	No	No	No	No	No
Bank FE	Yes	Yes	Yes	Yes	Yes
BankType-Time FE	No	No	No	No	No

This table reports results from estimating

$$\Delta\%D_{b,t} = \tau_t + \beta_1 \times \text{Equity}_b \times \text{May 1931} + \beta_2 \times \text{Liquidity}_b \times \text{May 1931}_t + \rho \times X_b \times \text{May 1931}_t + \gamma_b + \epsilon_{b,t},$$

where $\Delta\%D_{b,t}$ is the monthly growth rate of deposits and we distinguish between different types of deposit growth, including total deposits, interbank deposits, regular customer deposits, time deposits, and demand deposits. Further, May 1931_t is a dummy that takes the value of one after the Austrian Creditanstalt has failed, i.e., from May 1931 onwards. X_b is a set of bank-level controls, including bank size, share of foreign deposits, and share of demand deposits.
The model is estimated using data from October 1930 through November 1931. Robust standard errors are clustered at the bank level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 4: ***Deposit flows and bank distress***— *Data from October 1930 and March 1932.*

Dependent variable	Distress$_b$							
Month	November 1930	March 1931	April 1931	May 1931	June 1931	July 1931	August 1931	September 1931
	Panel A: Interbank Deposit Flows							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\%D$	0.050	-0.049	0.064	0.163	-0.284***	-0.112	0.127	0.206*
	(0.128)	(0.119)	(0.134)	(0.136)	(0.109)	(0.118)	(0.091)	(0.113)
N	126	121	118	118	114	112	113	109
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Customer Deposit Flows							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\%D$	-0.214	-0.490	-0.493	-0.117	0.250	-0.851**	-0.161	-0.007
	(0.558)	(0.428)	(0.467)	(0.382)	(0.428)	(0.394)	(0.257)	(0.184)
N	126	121	118	118	114	112	113	109
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports results from estimating the following model month-by-month from November 1931 through September 1931:

$$\Pr[\text{Distress}_b] = \alpha + \beta \times \Delta\%D_b + \rho \times X_b + \epsilon_b,$$

where Distress$_c$ is a dummy indicating whether a bank becomes distressed. $\Delta\%D$ is the growth in bank deposits in a given month and X_b a set of bank-level controls including the as bank's equity, liquidity, size, foreign deposits, share of demand deposits, and interbank deposits. We only keep banks in the estimation sample before they become distressed and exclude them as of the month of the distress event.
Robust standard errors in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5: ***Deposit flows and bank distress***— *Data from October 1930 and March 1932.*

Dependent variable	Distress$_b$							
Date	November 1930	March 1931	April 1931	May 1931	June 1931	July 1931	August 1931	September 1931
	Panel A: Time Deposit Flows							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\%D$	-0.210	0.197	0.066	-0.783*	0.522	-0.036	0.387	-0.070
	(0.322)	(0.260)	(0.484)	(0.440)	(0.415)	(0.273)	(0.265)	(0.257)
N	126	121	118	118	114	112	113	109
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Panel B: Demand Deposit Flows							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\%D$	0.357	-0.326	-0.276	0.496**	-0.424*	-0.392*	0.234	-0.258*
	(0.264)	(0.203)	(0.179)	(0.235)	(0.236)	(0.217)	(0.171)	(0.146)
N	126	121	118	118	114	112	113	109
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports results from estimating the following model month-by-month from November 1931 through September 1931:

$$\Pr[\text{Distress}_b] = \alpha + \beta \times \Delta\%D_b + \rho \times X_b + \epsilon_b,$$

where Distress$_c$ is a dummy indicating whether a bank becomes distressed. $\Delta\%D$ is the growth in bank deposits in a given month and X_b a set of bank-level controls including the as bank's equity, liquidity, size, foreign deposits, share of demand deposits, and interbank deposits. We only keep banks in the estimation sample before they become distressed and exclude them as of the month of the distress event.
Robust standard errors in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

A.1 APPENDIX [FOR ONLINE PUBLICATION ONLY]

- Appendix 1: The Banking System in Early 1931
- Appendix 2: Supplementary Figures
- Appendix 3: Supplementary Tables
- Appendix 4: Timeline of Historical Events

A.1.1 Appendix I: The Banking System in Early 1931

It is common practice to broadly group banks of the era by type, based in part on size and business model. The largest, measured by assets, were the national banks, based in Berlin. These were 6 banks that accounted for nearly 50% of all corporate lending and a third of all bank assets in Germany ((Born, 1967) & (Schnabel, 2004)). Four of these banks maintained an extensive network of branches [1] while all 6 lent across all of Germany. National banks were classical universal banks, but focused strongly on corporate lending. They often held both debt and equity securities (besides ordinary merchant credit) on their balance sheets.

The second group of banks were the credit banks (German: Kreditbanken). These were the by far the most numerous. Over our total sample period from 1925 to 1933, we count 125 unique credit banks [2]. Most were small, though though there is significant heterogeneity within our sample. What differentiated credit banks from national banks was that they maintained few, if any, branches outside their core city of operation. In keeping with their more limited geographic scope, these banks focused on local lending (within the town or region in which they were based).

A third group of banks were the Savings banks (German: Sparkassen) and their corresponding central institutions, the Girozentralen and Landesbanken (hereafter G&L banks). G&L banks were coordinating umbrella organizations that worked with set groups of local savings banks in certain pre-determined regions [3]. The savings banks themselves were local community banks that made small local loans and took local deposits, they accounted for a total of 20% of all bank assets and held predominantly mortgages. Their respective G&L banks were owned by either the state or the province in which they operated and accounted for over 14% of all bank assets. The function of the G&L bank was to hold savings banks' reserves, coordinate interbank payments, support the local savings banks with expert knowledge, and, crucially, help savings banks make large loans should the need arise. Small savings banks participated in almost no corporate lending without their respective G&L bank. Data on individual savings banks is only available annually. Data at the level of the G&L bank is available at the monthly basis. We focus on G&L banks in this paper and largely omit individual savings banks. Small savings banks focused almost exclusively on mortgage lending (when not lending via a G&L) and were distinct from the rest of the Banking system and remained almost unaffected by the turmoil of 1931. This can be seen, in particular, in the Appendix figure that shows deposits held at Savings banks. The larger G&L banks, however, with their exposure to communes and corporate borrowers, were affected.

The final group of banks operating in Germany were very small private banks. Data on these privately held banks is largely unavailable. However, they accounted for only a small fraction of total lending and total assets (6%) (**?**). These banks were not traded and typically owned by an individual banker or group of bankers. These banks dealt with securities and some corporate lending.

[1] Many of these banks can still be recognized today. They include, in 1930, the Deutsche Bank, the Commerzbank, the Dresdner Bank, the Darmstaedter and Nationalbank. By contrast, the Reichs-Credit Cooperative and the Berlin Merchant Cooperative had almost no branches and dealt with very wealthy depositors or regional banks as depositors.

[2] We include in this group the two large Munich-based banks that focused primarily on mortgage lending throughout all of Germany: The Bayerische Hypotheken- u. Wechselbank and the Bayerische Vereinsbank)

[3] Some regions made use of Girozentralen and others Landesbanken, though for all practical purposes these are interchangeable.

All Banks of the time were supervised by the Reichsbank. As part of the Dawes plan, the Reichsbank was fully extricated from any government control, and became an independent central bank. It could discount paper from commercial banks if that paper met certain "quality" requirements. Moreover, as discussed above, it pledged to maintain at least a 40% gold reserve of notes in circulation. Given that it wanted to signal to foreign investors that their investments in Germany were fully convertible, it usually held much more than 40%. The Reichsbank enforced no minimum capital requirement. In the past, German banks had held relatively large amounts of equity. In 1913, the year before the outbreak of the war, the ratio of equity relative to total assets stood at close to 1:4. In 1929 this ratio had fallen to between 1:10 and 1:15 (for some of the larger banks). Equity ratios had suffered partly due aggressive growth in the years after the currency reform.

Appendix **??** shows key variables of the the German banking system between 1929 and the end of 1931 as a whole, i.e. just before and after the crisis. As can be seen, total assets, deposits, loans, liquid assets, and inter-bank lending all remain fairly stable in the period before the crisis. This is despite the fact that the great depression had reached Germany by 1929. The start of the banking crisis is clearly visible in the contraction in aggregate assets and liquid assets. Loans contract much more slowly over a longer period.

Appendix Table A.1 shows key summary statistics for all the banks in our sample for the entire period between April 1925 and February 1933. As can be seen, the average bank has a equity-to-asset ratio of about 14%. This is comparable to the average equity-to-asset ratio of US banks today, which hovers around 11% based on Y9C data collected by the Federal Reserve. However, the heterogeneity between banks in our sample from 1931 is large, given the absence of regulation. Some are comprised of no more than 3% equity while at the other extreme, some banks make use of 30% equity-to-asset ratios.

The average bank in our sample also makes significant use of time deposits, as discussed above. Over half of all deposits are considered time deposits. This figure is slightly lower among US banks today, where a third of all deposits are time deposits. However, it is worth noting that this figure has been trending down for US banks for some time. Prior to 2000, 55% of all deposits among Y9C filing US banks were time deposits.

The inter-bank market played a significant role for banks in the 1920s and early 1930's. The ratio of deposits from banks, relative to total assets, hovered around 11%. Some banks, especially the Girozentralen, had almost a third of their assets funded by banks.

In the absence of any form of capital regulation, the driving factor behind a bank's choice of capital structure, in the late 1920's and early 1930's, is the riskiness of its asset base. Capital structure is therefore ultimately subject to market constraints and investor risk appetite. Some banks, like the Girozentralen, held significant amounts of liquid assets and could thus be highly leveraged. The large Berlin-based banks were invested in risky assets, holding business debt in many forms. However, these banks were also much more regionally diversified and significantly larger.It is possible that investors saw this size and regional diversification as a sufficient hedge. The banking sector of 1931 can thus be considered an ideal laboratory for an analysis of bank capital structure in the absence of bank capital regulation. It could be considered akin to today's shadow banking sector. However, unlike for today's shadow banking sector, banks in our sample were the primary financial intermediaries and did not have competition from a more regulated banking sector.

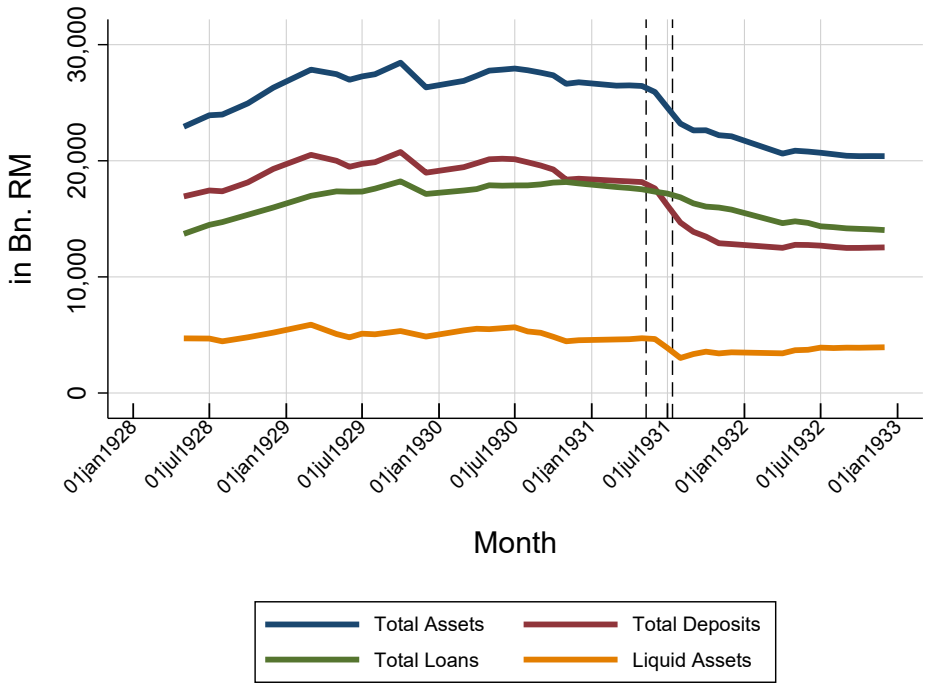
Appendix Figure A.6 relates certain bank characteristics to bank size in the period immediately preceding the crisis. Panel A shows the distribution of equity over assets, i.e. leverage, relative to bank size. Some banks make use of high levels of equity, while others could be considered aggressively leveraged by today's standards. The average bank maintains a leverage ratio around 13%, in the period immediately prior to the crisis. The heterogeneity in leverage highlights the differences in the appetite of investors for leverage across banks with different business models. To a large extent, the leverage of a bank is correlated with size. Larger banks make use of lower levels of equity relative to their total assets. It should be noted, however, that we do not have access to information on the riskiness of a bank's individual assets. As such, we cannot compute leverage relative to risk weighted assets. It is

possible that the regional diversification of large banks was seen as a source of stability in non-crisis times. In Panel B of Appendix Figure A.6, we show that the use of time deposits, i.e. wholesale funding, also correlates with bank size. Larger banks are more likely to make use of wholesale funding in the pre-crisis period. This is likely a function of the business model, as larger banks, even today, are somewhat less reliant on individual demand depositors. Panel C depicts the relationship between size and a reliance on inter-bank funding. Here too, we find that larger banks are more dependent on inter-bank deposits. Ultimately, this implies that larger institutions have significantly higher shares of very run-able capital held by informed investors. This makes these institutions more susceptible to aggregate contractions in short term funding. Finally, in Panel D, we show that liquidity mismatch is negatively, though weakly correlated with size. This implies that, despite a larger reliance on run-able and short-term funding, large banks hold fewer liquid assets.

We extend our analysis with firm-level data. Firm balance sheet data is pulled from archival copies of the Salings Boersenpapiere. This was a handbook for investors published every year. It included information on a firm's board composition, major events in the firm's operations, letters to investors and, importantly, firm balance sheets and firm income statements at year end. One major section of the Salings handbook focused on large companies listed or join-listed on the national stock exchange in Berlin. In Appendix Figure A.7, Panel A, we can see that the average firm has far higher levels of Equity to assets in 1931 than banks; i.e. banks are much more highly leveraged than non-banks. This reflects the willingness of investors to accept different levels of leverage in the financial sector.

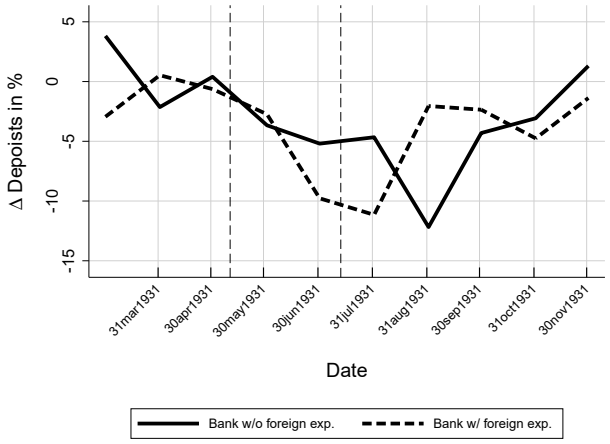
We can further compare bank and firm wholesale funding. This can be seen in Appendix Figure A.7. Here, we combine demand and time deposits into short term funding. We do this because, as could be observed in the analyses discussed above, time-deposits are short-term during the crisis. We can see that most banks make use of a very short term-oriented funding structure. We can contrast this to non-financial firms, which also make use of some short term and some long term funding. Again, we can see that the banks behave very differently from non-financial firms, preferring to rely on short term funds to a far greater extent. This highlights the classical maturity transformation in which traditional banks engage. It remains open, however, whether banks understood the runnable nature of time deposits during a crisis, as there had been no contraction of time deposits of this magnitude since the end of hyperinflation in 1923.

A.1.2 Appendix II: Figures

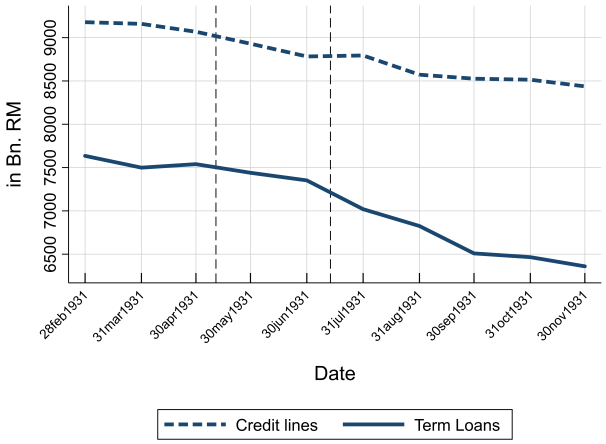


(a) *Key Bank Characteristics between 1929 and 1932 size*

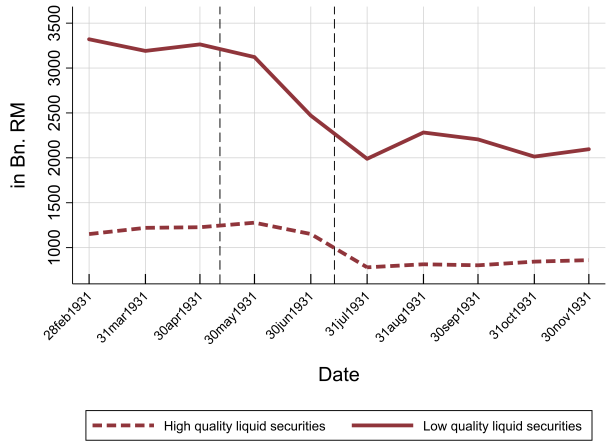
Figure A.1: ***Bank characteristics*** *This figure shows the development of key bank characteristics over time. The onset of the crisis as well as the failure of the Danat-Bank (the high-point of the crisis) are marked by dashed vertical lines.*



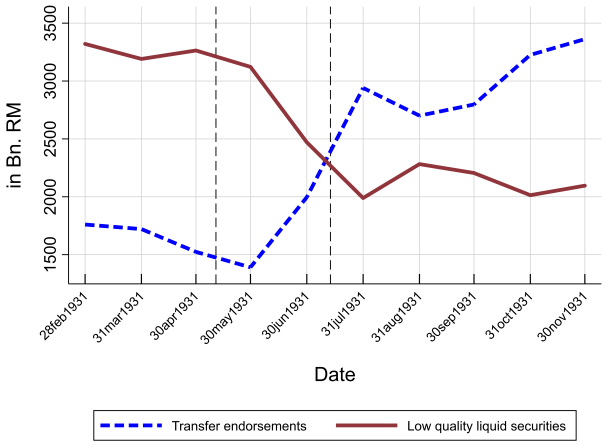
(a) *Average month-to-month growth rate of bank-level deposits from March 1931 to November 1931, splitting banks into those that make use of foreign-denominated deposits and those that do not.*



(b) *Aggregate level of outstanding credit lines and term loans between February 1931 and November 1931.*

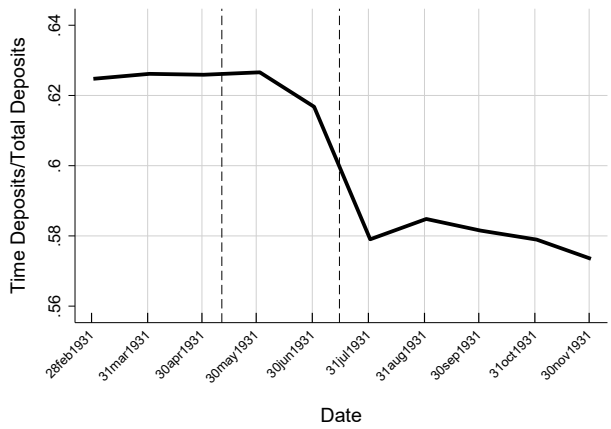


(c) *Aggregate levels of "high" and "low" quality liquid securities from February 1931 through November 1931. High quality liquid securities are defined as Treasury's and high quality bills of exchange. Low quality securities are comprised of corporate bonds and municipal bonds.*

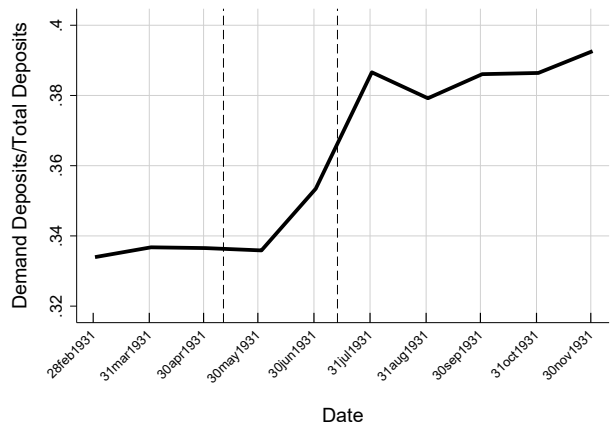


(d) *Aggregate levels of "low" quality securities and off-balance sheets transfer endorsements from February 1931 through November 1931. Transfer endorsement are an off-balance sheet liability stemming from retaining the credit risk of a claim sold.*

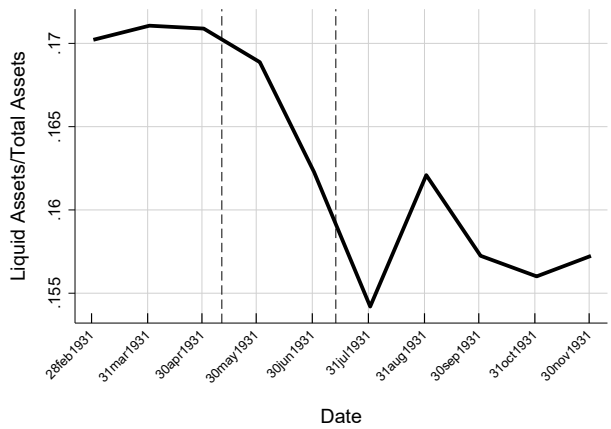
Figure A.2: ***Aggregate dynamics II.*** *The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January.*



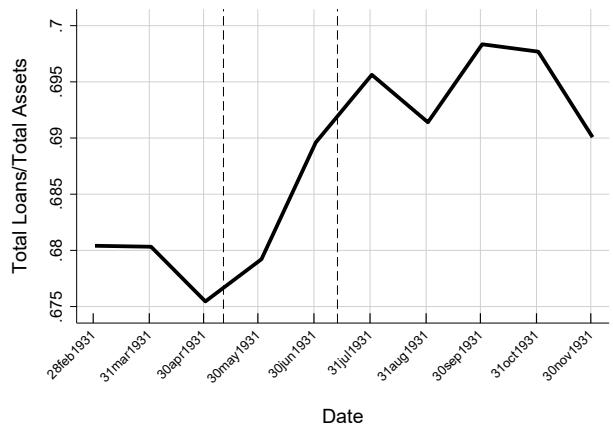
(a) *Ratio of aggregate time deposit to total assets between February 1931 and November 1931.*



(b) *Ratio of aggregate demand deposits to total assets between February 1931 and November 1931.*

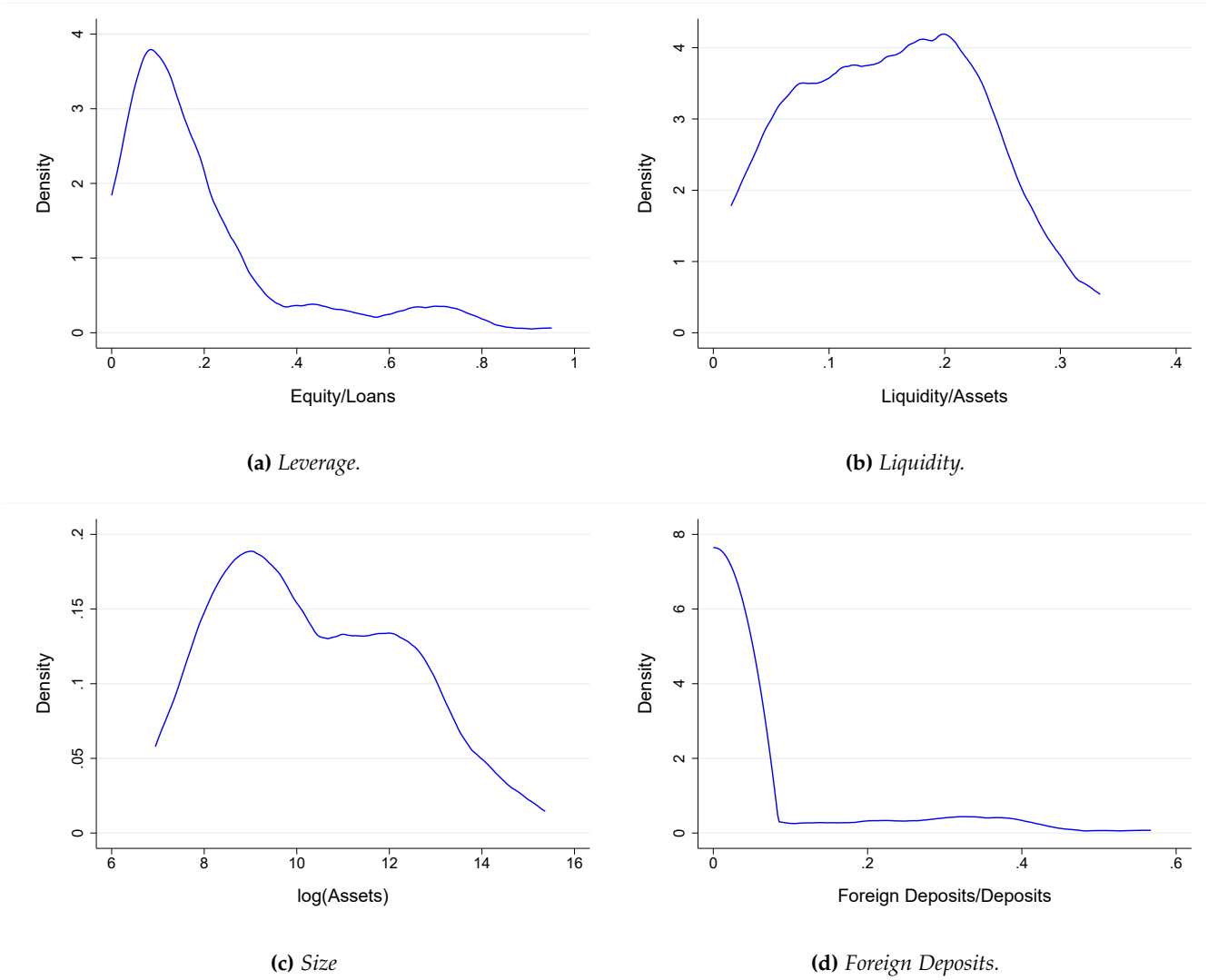


(c) *Ratio of aggregate liquid assets to total assets between February 1931 and November 1931.*



(d) *Ratio of total loans to total assets between February 1931 and November 1931.*

Figure A.3: ***Aggregate dynamics III.*** *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, corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January.*



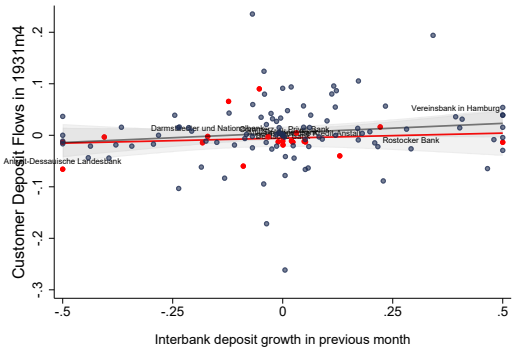
(a) *Leverage.*

(b) *Liquidity.*

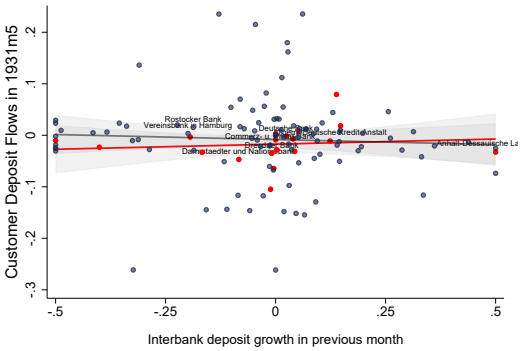
(c) *Size*

(d) *Foreign Deposits.*

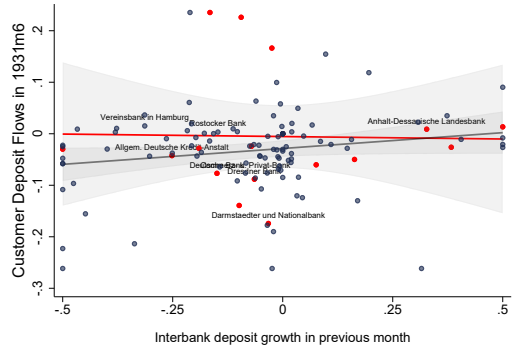
Figure A.4: *This figure plots kernel densities for the ratio of bank equity to total credit, liquid assets to total assets, the logarithm of total assets and the ratio of foreign deposit to total deposits. The ratio's are calculated as the bank-level average between September 1929 and September 1930. Data are restricted to banks reporting balance sheets reported in October 1931.*



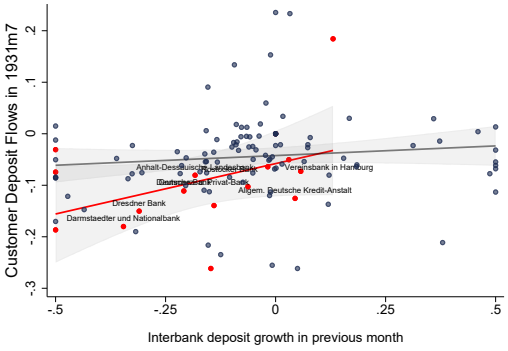
(a) *April 1931.*



(b) *May 1931.*

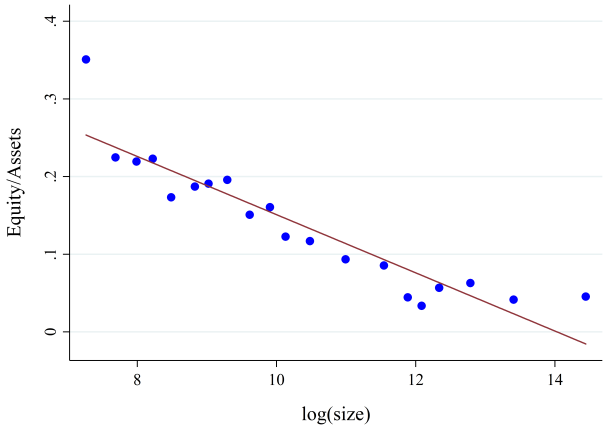


(c) *June 1931.*

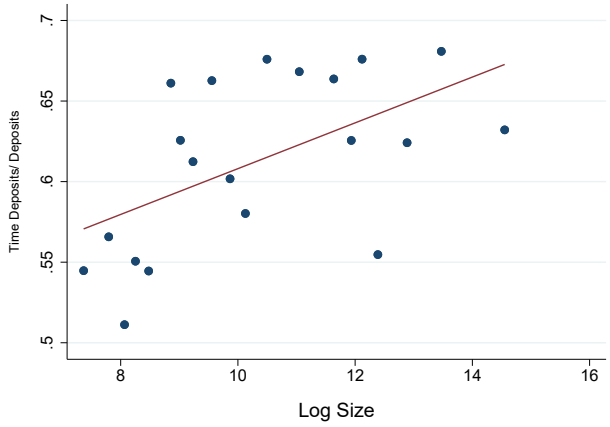


(d) *July 1931.*

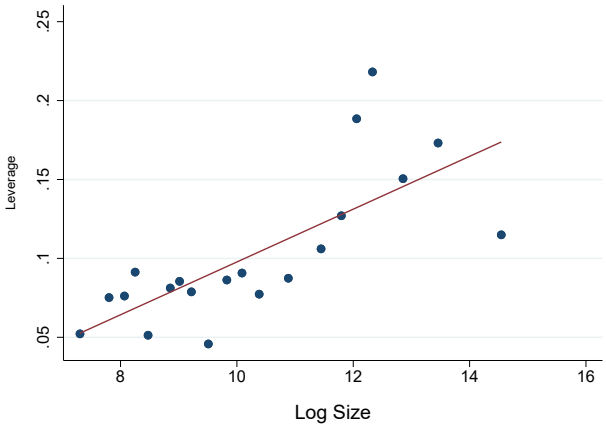
Figure A.5: ***Customer Deposit Flows and Interbank Deposit Flows.*** .



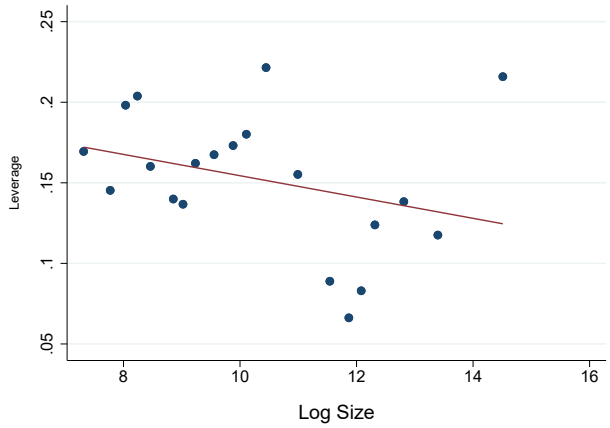
(a) *A. Leverage vs. size*



(b) *B. Time deposits vs. size*

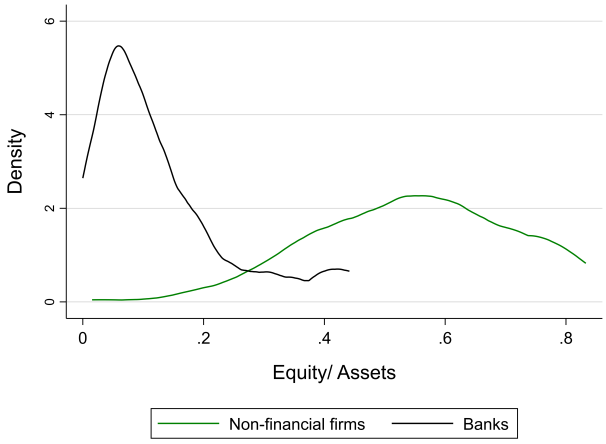


(c) *C. Interbank funding vs. size*

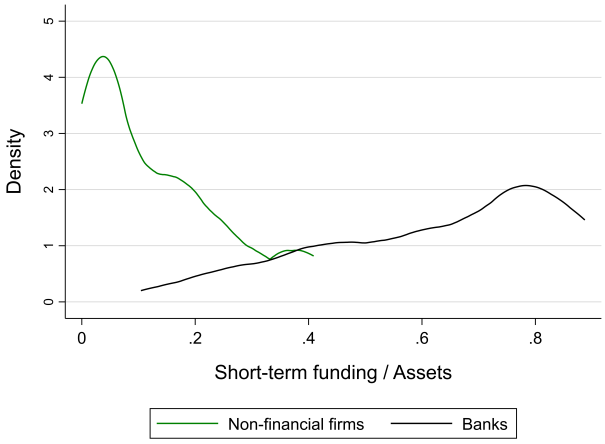


(d) *D. Liquidity mismatch vs. size.*

Figure A.6: ***Bank characteristics relative to size*** *The above are scatter-plots of bank characteristics: leverage, time deposits to total deposits, share of inter-bank deposits to total deposits, and liquidity mismatch relative to the log size of the bank. Bank characteristics and bank size are calculated for the pre-crisis period (June 1929 to March 1931).*



(a) *A. Bank vs. firm leverage*



(b) *B. Bank vs. firm liquidity mismatch*

Figure A.7: ***Banks vs, firms*** *The above figures depict kernel density plots for leverage and the use of short term funding. Each figure depicts banks and non-financial firms separately. Leverage and the use of short term funding are calculated for the pre-crisis period (June 1929 to March 1931).*

A.1.3 Supplementary Tables

Table A.1: *Summay Statistics for Key Variables*

N	Mean	StDev.	10th Perc	25th Perc	Median	75th Perc	90th Perc	
Equity / Assets	6018	.14	.13	.03	.05	.10	.18	.34
Equity / Total Credit	6015	.33	1.56	.04	.07	.15	.28	.55
Liquid Assets/Total Assets	6159	.16	.11	.037	.08	.15	.22	.28
Log Total Assets	6159	10.255	2.00	7.79	8.58	9.99	11.95	12.97
Deposits / Total Assets	6159	.65	.23	.29	.50	.72	.83	.88
Time Deposits / Deposits	6088	.56	.20	.32	.46	.57	.68	.81
Demand Deposits / Deposits	5913	.37	.17	.16	.27	.37	.47	.57
Due from Banks / Total Assets	6108	.07	.07	.01	.02	.05	.09	.15
Bank Balance / Total Assets	5875	.12	.13	.01	.03	.07	.16	.32

This table shows some key bank characteristics for our entire data sample (from April 1925 to February 1933).

Table A.2: ***Descriptive statistics***

	Mean	Std	10th Perc	25th Perc	Median	75th Perc	90th Perc	N
Equity/Total Credit	0.21	0.22	0.04	0.06	0.13	0.25	0.57	127
Liquid Assets/Total Assets	0.15	0.09	0.04	0.08	0.15	0.21	0.26	127
log(Total Assets)	10.29	2.03	7.84	8.47	9.93	12.00	13.02	127
Foreign Deposits/Deposits	0.04	0.11	0.00	0.00	0.00	0.00	0.21	127

This table shows the distribution of the ratio of bank equity to total credit, liquid assets to total assets, the logarithm of total assets and the ratio of foreign deposit to total deposits. The ratio's are calculated as the bank-level average between September 1929 and September 1930. Data are restricted to banks reporting balance sheets reported in October 1931.

Table A.3: ***Statistics for the 40 largest banks***

Bank	Total Assets	Deposits	$\frac{\text{Equity}}{\text{Credit}}$	$\frac{\text{Liquid Assets}}{\text{Total Assets}}$	$\frac{\text{Foreign Deposit}}{\text{Deposit}}$	$\frac{\text{Interbank Claims}}{\text{Total Assets}}$	$\Delta\%D$ in Crisis	Failure Date
Deutsche Bank	5,253	4,508	.09	.26	.37	.07	-.05	February 1932
Darmstaedter und Nationalbank	2,642	2,395	.04	.24	.43	.08	-.1	July 1931
Dresdner Bank	2,539	2,297	.07	.25	.44	.1	-.07	July 1931
Commerz- u. Privat-Bank	1,810	1,523	.06	.23	.39	.08	-.06	
Preusische Staatsbank (Seehandlung)	1,239	1,198	.02	.24	.03	.07	-.08	
Deutsche Girozentrale, Dt. Kommunalbk.	1,104	453	.05	.12	.01	.11	-.01	
Bayerische Hypotheken- u. Wechselbank	996	272	.05	.09	.16	.05	-.01	
Reichs-Kredit-Gesellschaft A.-G.	704	619	.1	.22	.53	.13	-.05	
Bayerische Vereinsbank	672	221	.06	.1	.09	.07	-.02	
Landesbank der Prov. Westfalen	502	185	.02	.03	0	.06	-.01	
Berliner Handelsgesellschaft	485	421	.1	.19	.74	.13	-.04	
Barm. Bk.-B. hinsberg	450	366	.12	.18	.54	.12	-.04	
Nassauische Landesbank	441	210	.02	.05	0	.08	-.06	
Allgem. Deutsche Kredit-Anstalt	433	356	.14	.22	.27	.06	-.04	July 1931
Bayerische Staatsbank	393	357	.13	.23	.03	.11	-.05	
Bayer. Gemeindebank	356	118	.05	.03	0	.14	-.06	
Mitteldeutsche Landesbank	346	155	.06	.09	0	.08	-.08	
Girozentrale Hannover, oefftl. Bankanst.	314	166	.12	.13	0	.1	-.02	
Saechsische Staatsbank	249	226	.08	.21	.13	.15	0	
Girozentrale Sachsen, oeffentl. Bankanst.	249	208	.13	.18	0	.22	-.02	
Deutsche Bau und Bodenbank	210	130	.19	.15	.17	.09	-.04	
Hannov. Landeskreditanstalt	210	9	0	.06	0	.04	-.05	
Landesbank der Provinz Hannover	208	95	.01	.02	0	.17	-.05	
Berl. Stadtbk. (Girozentrale d. Stadt Berlin)	205	181	.05	.16	0	.25	-.01	
Brandenb. Provinzialbank und Girozentrale	204	105	.07	.04	0	.12	-.02	
Braunschweig. Staatsbank	187	107	.04	.09	0	.16	-.04	
Landesbank. d. Prov. Ostpreussen	179	35	.04	.04	0	.03	-.01	
Thueringische Staatsbank	168	115	.01	.22	0	.05	-.01	
Hessische Girozentrale	167	71	.01	.02	0	.1	-.03	
Badische Girozentrale	166	101	.08	.05	0	.06	-.03	
Wuerttembergische Girozentrale	165	103	.07	.04	0	.21	0	
Kommunalbk. f. Schlesien, oefftl. Bankanst.	163	85	.04	.07	0	.1	-.03	
Landeskreditkasse Kassel	158	29	.01	.05	0	.08	.01	
Deutsche Landesbankenzentrale A.-G.	153	85	.07	.05	.13	.24	-.06	
Provinzialbank Pommern (Girozentrale)	152	61	.05	.08	0	.06	-.04	
Giro-Z. (Kommunalbk.) f. d. Ostmark.	140	43	.07	.02	0	.01	-.03	
Hessische Landesbank	124	18	.01	.03	0	.02	-.02	
Bank fuer auswaetrigen handel	123	108	.12	.07	.43	.12	-.11	
Provinzialbank Oberschles.	114	41	.06	.02	0	.01	-.02	
Vereinsbank in Hamburg	111	81	.19	.2	.35	.03	-.02	

This table shows key characteristics for the 40 largest banks in our sample. Total assets, total deposits (both in million Reichsmark), equity to credit, liquid assets to total assets, and the foreign deposit ratio are calculated as the mean for the period September 1929 to September 1930. Change in deposits during the crisis is calculated as the average monthly change from September 1930 to September 1931.

Table A.4: ***Unexplained variation in deposit flows and bank distress (excluding early failures)***— *Data from October 1930 and March 1932. Dropping banks that become distressed between May and July 1931.*

Dependent variable	$\widehat{\epsilon_{b,t}}^{Distress}$						
Date	March 1931	April 1931	May 1931	June 1931	July 1931	August 1931	September 1931
	Interbank Deposit Flows						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\widehat{\epsilon_{b,t}}^{\Delta\%D}$	0.066	-0.204*	-0.217**	0.053	0.131	0.037	-0.175**
	(0.119)	(0.124)	(0.101)	(0.132)	(0.095)	(0.088)	(0.086)
N	112	111	114	112	111	114	110
R^2	.0031	.028	.031	.0023	.021	.0014	.032
	Customer Deposit Flows						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\widehat{\epsilon_{b,t}}^{\Delta\%D}$	-0.030	0.009	-0.030	-0.125	-0.063	-0.156*	0.057
	(0.106)	(0.091)	(0.091)	(0.147)	(0.088)	(0.092)	(0.074)
N	108	105	108	106	105	107	103
R^2	.00018	.000016	.00016	.005	.00098	.0072	.00083

This table reports results from estimating the following model month-by-month

$$\widehat{\epsilon_{b,t}}^{\text{Distress}} = \alpha + \gamma \times \widehat{\epsilon_{b,t}}^{\Delta\%D} + v_b,$$

where $\widehat{\epsilon_{b,t}}^{\text{Distress}}$ is the residual from estimating Equation (1). Further, $\widehat{\epsilon_{b,t}}^{\Delta\%D}$ is the residual from estimating Equation (2). We only keep banks in our data before they become distressed and exclude them as of the month of the distress event.
Bootstrapped standard errors clustered at the bank level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

A.1.4 List of events

- November 15, 1923: Hyperinflation ends (Rentenmark)
- August, 1924: "Dawes Plan"
- October 5-16, 1925: Treaty of Locarno
- August 31, 1929: "Young Plan" finalized
- October 24, 1929: Stock market crash begins on "Black Thursday"
- March 29, 1930: Brüning becomes Chancellor
- September 14, 1930: German Federal Election; governing coalitions become impossible
- May 11, 1931: Failure of Austrian *Creditanstalt*
- July 13, 1931: Failure of *Danatbank* and start of capital controls
- September 19, 1931: England abandons the Gold Standard
- July 9, 1932: "End of reparations"
- July 31, 1932: German Federal Election
  - NSDAP wins 37.3%
- January 30, 1933: Hitler becomes Chancellor

Crisis events

- May 11, 1931: Failure of *Creditanstalt*
- May-June, 1931: Foreign depositors begin to flee Austria and Germany. Most affected of the large banks: Danat & Dresdner, followed by Deutsche and Commerzbank. No st-foreign deposits with Berliner Handelsgesellschaft
- May 31, 1931: Failure of *Karstadt* and *Nordstern* encourages additional (primarily international) withdrawals
- June 9-11: Brünning cabinet claims economy too weak to support reparations, causing further panic amongst foreign (and domestic) depositors
- June 17: Nordwolle announces "substantial losses" (leading to bankruptcy), endangering Danatbank and Dresdner Bank
- June 20: Hoover Moratorium suspends foreign debt servicing; resistance from the French government stalls implementation for another month
- June 17-July 11, 1931: Public connects *Danatbank* and *Nordwolle*, leading to further substantial deposit outflows
- July 12, 1931: Government fails to convince large banks to recapitalize or guarantee *Danatbank*.
- July 13, 1931: "Failure" of *Danatbank*. All counters closed. State guarantees deposits. Nationwide panic sets in. Run intensifies on all banks to the point that, by midday, many banks (esp. in Berlin) payout only 20%

- July 11-14, 1931: Depositor run force *Dresdner* and *Rheinische Landesbank* to close their counters; admit illiquidity and ask for government help
- July 14-15, 1931: State imposes bank holiday
- July 15- August 5, 1931: Partial bank holiday and capital controls remain in effect
- August 1, 1931: *Discontsatz* raised to 15% to stem foreign deposit outflow; puts pressure on national economy
- August 15, 1931: *Layton report* finds Germany cannot regain investor confidence while paying reparations
- August 19, 1931: *Stillhalteabkommen* reduction of interest rates and an (initial) 6 month freeze on repayment of foreign debt
- September 19, 1931: *Aktienrechtsnovelle* changes in corporate law that enables more aggressive write-off of debt and assets w/o stock holder consent
- September 19, 1931: New banking supervisory authority and a Commissar for Banks created. Banks forced to be fully transparent
- October 6, 1931: *Sparkassenreform* German savings banks forced to hold more liquid assets with their GiroZ. Limits to mortgage and communal lending. Direct control of community limited
- December 8, 1931: Interest rates lowered. Competition had driven interest rates on deposit accounts up. Now capped at 6%
- February 22, 1932: Reich allows itself to restructure banks and hold bank stock via emergency law.
- March 11, 1932: Reich restructures large banks. Reichsbank holds 2/3 of Dresdner-Danat, 1/2 of Commerzbank and 1/3 of Deutsche Bank