# Micro-evidence from a system-wide financial meltdown: The German Crisis of 1931

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**Abstract**

This paper studies the determinants of bank stability and the informational content of deposit flows in a major financial panic, the run on the German banking system in 1931. First, we document the dynamics of the financial panic and show that demand deposits are—despite the absence of deposit insurance—largely stable and the run is centered around the collapse of interbank and wholesale funding. Second, we show that while the banking system is losing deposit funding on aggregate, deposits are also partially reshuffled. Third, we exploit the cross-sectional variation in deposit flows and bank distress to identify whether depositors discriminate between fragile and stable banks. We find that interbank deposit flows predict subsequent bank distress early on. In contrast, regular depositors are more likely to withdraw from distressed banks only at later stages of the run and only after the interbank market has started to collapse. Finally, at the height of the crisis, all deposit flows become generally uninformative in line with withdrawal decisions being panic-driven and independent of a specific bank's fundamentals.

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# 1 Introduction

What determines bank stability during a system-wide financial meltdown? The theoretical literature has made great progress on the understanding of the fragility of financial institutions due to maturity and liquidity mismatch (see, e.g., Diamond and Dybvig, 1983; 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).

In this paper, we exploit the unique historical incident of a run on the entire German banking system during the summer of 1931. Our analysis identifies heterogeneity in bank stability and depositor behavior as crucial determinants of the dynamics of a system-wide financial panic. First, we show that while the banking system is losing deposit funding on aggregate, deposits are also partially reshuffled within the system and some banks receive deposit inflows during the run. Second, 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 very 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 stages of the run and only after the interbank market has started to collapse. Finally, at the height of the crisis, deposit flows are generally uninformative and depositors seek safety not within, but outside of the banking system. This finding is in line with withdrawal decisions being panic-driven and independent of a specific bank's fundamentals.

We proceed in two steps. In the first step, we provide a comprehensive empirical description of the dynamics of the German Crisis of 1931. 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 which extent deposits leave the banking system. In the second step, we then exploit the cross-sectional variation in bank stability and study the informativeness of deposit flows for bank

distress. In particular, we exploit that as econometricians we know what banks ultimately become distressed throughout the run. This allows us to study whether unexplained variation in deposit flows during the run can predict bank distress.

There are three reasons why the German crisis of 1931 is a close to ideal laboratory to study a system-wide bank run. 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 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 then accompanied by an aggregate outflow of time deposits.

Strikingly, we find that—despite the absence of deposit insurance—demand deposits are stable throughout most of the run. In contrast, the run is almost entirely centered around the withdrawal of longer maturity time deposits—the modern day equivalent of wholesale funding. Only after aggregate deposits have fallen by almost 25% and when a major German bank ("*Darmstädter und Nationalbank*" or "*Danatbank*") declared bankruptcy, demand depositors start to withdraw across the board, marking the third and final phase of the run. The demand depositor run then triggered the federal government to intervene and to implement fiscal measures to contain the crisis.

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 finding can, however, be rationalized either 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). In particular, demand deposits were typically small and held by households for transaction

purposes. In contrast, time deposits tended to be large and held by firms or large and possibly foreign investors, which are arguably more attentive and better informed than the average household depositor. This interpretation is further supported by the fact that banks which rely more on foreign depositors, arguably also more attentive and sophisticated, are subject to the withdrawals earlier in the run. Thus, 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).

We further document that there is large heterogeneity in bank stability. 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. As a consequence, some banks are receiving deposit inflows during the run. Further, we calculate that of those deposits that are leaving the banking system, around 30% are exchanged into Gold. The remaining contraction is largely accounted for by a contraction of inside money (around 60%) and we calculate that only few depositors store withdrawn currency "under the mattress" (up to 10%).

After documenting the dynamics of the run descriptively, we study heterogeneity in depositor information in more detail. Here, we exploit that ex-post it is observable which banks become distressed during the run and which banks survive. Specifically, using methods developed to identify private information in insurance markets (see, e.g., Chiappori and Salanie, 2000), we investigate whether unexplained deposit flows predict unexplained variation in bank distress. In particular, we define a bank to be distressed if it either defaults, receives a bailouts, or is subject to a distressed merger during or after the run. We then proceed in two steps. First, we explain deposit flows and bank distress independently by bank balance sheet characteristics. Second, we regress the unexplained variation in bank distress on the unexplained variation in deposit flows. Exploiting the granular nature of our data, we then test whether the unexplained growth of different types of deposits (interbank vs. regular deposits, demand deposits vs. time deposits) has different predictive power for unexplained variation in bank distress in different stages of the run.

An important caveat of our empirical approach is that we cannot identify to which extent withdrawals at an individual bank are primarily caused by the prospect of default or to which 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, 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 banks other depositors are likely to conceive as fragile.

Our findings reveal that there is large heterogeneity in the informativeness of deposit flows different types of deposits and across time. We find that interbank deposit flows are predictive of eventual bank distress in the month before the run starts as well as in the first month of the run, i.e., from March 1931 through May 1931. That is, bank deposit flows are predicting bank distress *before* aggregate deposits start to contract, indicating that banks identify other banks' future distress. This finding is in line with banks having the most information about the state of the banking system and being the most sophisticated type of depositors.

Importantly, other types of depositors are also able to discriminate between troubled and non-troubled banks. However, the flow of deposits becomes predictive of bank distress only during the second phase of the run, when aggregate deposits are contracting at a high rate in June 1931. Nonetheless, 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 depositors shortening maturities in the early phase of the run at banks that are likely to become distressed.

However, at the height of the crisis, in July 1931, deposit flows become entirely uninformative of bank distress and depositors cease to discriminate between banks' fundamentals. As depositors are withdrawing from all banks equally—irrespective of the whether a bank is ultimately distressed or not—this finding is in line with a system-wide panic in which depositors are attempting to seek safety outside of the banking system.

By exploiting the cross sectional variation in our deposit data as well as the granularity of our bank data we are further able to study the determinants of bank stability. Theories of bank runs predict that, ceteris paribus, banks with a lower leverage and lower liquidity mismatch are less likely to be subject to a run (see, e.g., Rochet and Vives, 2004; Kashyap et al., 2017). In line with the notion that depositors discriminate between more and less stable banks and are seeking safety within the banking system, we find that both, bank equity and bank liquidity, are positively linked to bank stability during the crisis. In particular, while banks experience an average outflow of time deposits of 3.1 percentage points per month during the crisis, a one standard deviation increase in the ratio of bank equity over bank credit is associated with a 0.6 percentage points lower outflow during the bank run. In comparison,

a one standard deviation increase in the ratio of liquid assets over total assets is associated with a 0.9 percentage point lower outflow of time deposits.

Further studying the effects of equity and liquidity on bank stability on bank credit provision, we find that only better capitalized banks are more likely to provide relatively more credit during and immediately after the crisis. Hence, while equity and liquidity both are associated with a larger degree of bank stability, only bank equity is associated with credit provision after the bank run. The fact that bank capital is associated with a faster recovery after a financial crisis is in line with models in which bank capital is a key determinant of bank credit provision (see, e.g., Holmstrom and Tirole, 1997; Brunnermeier and Sannikov, 2016). Moreover, the finding is also in line with evidence on aggregate credit recovery after banking crises (see, e.g., Jordà et al., 2017; Baron et al., 2019).

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 is a large number of theoretical studies of the subject, which can broadly be categorized into three generations of models. The first generation of bank run models explains bank runs 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.[1] 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.

[1] 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.

An alternative 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.[2]

The second generation of models shows under which conditions models of self-fulfilling bank runs have a unique equilibrium.[3] 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.[4] 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.

Finally, the third generation of bank runs models provides theories of dynamic bank runs. He and Xiong (2012) show that dynamic coordination games, in which rollover decision are based on anticipated future rollover decision 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. There 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 data is only available at a low frequency, or governments intervene before a system-wide bank run fully plays out. Therefore, many papers focus on the runs on individual institutions. For instance, Kelly and O Grada (2000) study depositor runs using depositor-level data in a New York bank during the Panics of 1854

[2]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.

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

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

and 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. Finally, Martin et al. (2018) show that, prior to bank failures, outflows of uninsured deposits are offset with inflows of insured deposits. Finally, Artavanis et al. (2019) use deposit-level data from a run on a Greek bank in 2015 and are able to identify to which extent depositors are withdrawing due to concerns about bank solvency and to which extent their behavior is driven by strategic motives and concerns of other depositors withdrawing.

While our data do not allow us to study individual depositor 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.[5] 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 depositors discriminate between more and less stable banks during the run. The key advantage of our empirical approach is that the richness of our data allows us to test for heterogeneity in depositor information.

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

[5]Calomiris and Mason (2003a) study the real effects associated with the banking crisis. Calomiris and Mason (1997) provide an account of the bank failures in Chicago during 1932.

failure of Lehman Brothers.[6] 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.[7]

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.[8] 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 Termin (2003) argue that the crisis was largely a currency crisis and not a banking crisis.[9] 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) 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 believe 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 to 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 demand and time deposits, credit lines and

[6] 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.

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

[8] Papers studying the more general role of the economic and political crisis in the rise of political extremism and the Nazi party are provided by Galofré-Vilà et al. (2017) and Doerr et al. (2018).

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

terms loans, high and low quality liquid assets, as well as secured and non-secured lending.[10]

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 and 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.[11]

## 4 The German Crisis of 1931

We start by providing a comprehensive description of the dynamics of the system-wide bank run. Our data allow us to review 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.[12] 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,[13] and finally culminated in

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

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

[12]More information of the macroeconomic environment in which the crisis took place are provided in the Appendix.

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

the failure of Germany's second largest banks, the Danatbank on July 13.[14] 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.[15] 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 March 1932.[16]

German banks were not contractually linked to the Creditanstalt, whose failure had precipitated 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 Termin, 2003). As mentioned in Section 2, we focus on studying the dynamics of the run on the banks and the determinants of bank stability, but remain agnostic on 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,[17] 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,[18] 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

[14]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.

[15]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.

[16]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.

[17]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).

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

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 hence 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.

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 slower 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. Figure 2a 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. That is, the run is largely a run in the wholesale funding market. Narrative evidence suggests that demand depositors only started to withdraw on July 13, 1931 when the Danatbank closed it branches and the federal government started to intervene. However, the run by demand depositors was then contained by a two-day bank holiday and the provision of government guarantees thereafter.

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, and are only withdrawn when Danatbank failed. The finding is thus 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.[19] The finding is, however, in line with the empirical evidence on different

[19]Ferguson and Termin (2003) use the fact that demand deposits are stable as the key piece of evidence that the crisis is not

depositor types behaving different during in bank runs (Iyer and Puri, 2012; Iyer et al., 2016). In our setup, time deposits represent 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 typically held by households for transactions purposes. The finding can thus be rationalized by the fact that the latter type of depositor is arguably less sophisticated and less attentive.[20]

This interpretation is further supported when we split banks into two groups: those that make extensive use of foreign deposits and those that do not, see Figure 1d. While both types of banks become subject to the run eventually, early withdrawals are stronger at those banks that rely on foreign funding. 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 Termin, 2003; Schnabel, 2004).[21] Moreover, withdrawals at banks with foreign deposits start to slow down after July, in line with the introduction of capital controls.[22]

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.

Exploiting the granularity of our data, we 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

a banking crisis.

[20]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.

[21] Narrative evidence suggests that 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.

[22]Capital controls were, however, far from complete and foreign withdrawals continued nonetheless throughout the fall as also discussed by James (1984).

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.

Next, we turn to the question of how banks meet deposit withdrawals throughout the crisis. What types of assets are sold first? Theoretical predictions on what assets should be liquidated vary. To avoid the exposure to the costly fire sale, liquid assets should be sold first (Allen and Gale, 1994). However, liquid assets also have an option value if illiquidity increases further, suggesting that less liquid assets should be sold to front run sharp falls in prices (Ang et al., 2014; Brown et al., 2010).

Figure 1b above revealed that the securities portfolio contracts together with deposit outflows. Using our data, we can categorize securities into those of relatively high and those of low quality. High quality liquid securities include Treasury's and highly liquid bills of exchange, both considered to be cash equivalents. Low quality liquid securities are all other securities other than equities and hence include corporate bonds and municipal bonds.

Figure 2c plots the aggregate levels of the two types of securities throughout 1931. While both, high and low quality, securities contract by approximately 40%, holdings of low quality liquid assets begin to decrease much earlier than more liquid assets and highly liquid assets only start to be used to meet withdrawals at a later stage. In the aggregate, relatively lower quality liquid assets are hence more likely to be liquidated in the early phase of the run.[23]

[FIGURE 2 ABOUT HERE]

Further, our data allow us to identify that banks make their low quality securities relatively more attractive by providing off-balance sheet guarantees for the asset's credit risk. Specifically, banks were allowed to provide "transfer endorsements", which effectively allowed banks to exchange an asset for cash while retaining the exposure to the credit risk of the underlying asset. Were the underlying credit risk to materialize, and the asset fail to realize the contractually specified payout, a bank that had provided a transfer endorsement would have to pay the ultimate holder for their losses.[24] Importantly, the banks were not required to report these shadow liabilities as on-balance sheet liabilities, but could

[23]Note that the result may be confounded by the fact that bank with lower quality liquid securities may be more fragile and hence more likely to be subject to the run early on.

[24]This practice became increasingly popular in the late 1920's, as macroeconomic conditions deteriorated and banks grew worried about the quality of certain bonds and other debt instruments. The Reichsbank too, would only have discounted high quality securities or assets whose value was guaranteed. These guarantees obviously represented an enormous risk to the banks.

book these as off-balance sheet liabilities.

Figure 2d shows that at the onset of the crisis total transfer endorsements shoot up by about the same amount as low quality securities fall. That is, the increase in transfer endorsement correlates strongly with the aggregate contraction in low quality securities. We interpret this as evidence that endorsements are used to increase the liquidity of relatively low quality assets that would otherwise not have been liquid or discountable with the Reichsbank.

The above evidence, in particular Figure 1a and Figure 1b, show 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 2b

Altogether, the facts discussed above imply that as the run continues, on the asset side, overall illiquidity shoots up (Brunnermeier, 2009). On the liability side, maturities of deposits that remain in the banking system are on average shorter. This is also documented in Figure 3, which shows that throughout the run, as bank are liquidating securities and losing time deposits, banks become less liquid.

[FIGURE 3 ABOUT HERE]

**The Reichsbank** Our data allow us further to 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 4a 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 4c. 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 4 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 4d. 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 4b 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". Moreover, Figure 4b reveals that deposits are more likely to be converted into Gold in the earlier phase of the run. Given that early withdrawals are more likely to stem from foreigners, see Figure 2a, it is thus indicative of foreign funds leaving Germany early on. In the latter stage, much fewer deposits are converted into gold and the contraction of deposits stems from a contraction in inside money.

[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.

## 5 Informational content of deposit flows

In this section, we study the heterogeneity in depositor information in more depth. Our empirical strategy exploits that, as econometricians, we can observe which banks become distressed throughout the crisis and which banks survive the run. First, the cross-sectional variation in bank stability thus allows us to investigate which balance sheet characteristics are possible determinants of bank stability. Second, we are able to determine whether depositors discriminate between banks that ultimately become distressed and those that do not. It therefore 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.

While we have reliable data for around 120 unique banks during the phase of the run, 21 of these banks become distressed at some point during the crisis. That is, these banks either go out of business, are subject to a distressed merger, or are bailed out and restructured during or after the crisis, i.e., between May 1931 and August 1932. Table 2 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 July 1931 but also the restructuring of *Deutsche Bank* in early 1932.

[TABLE 2 ABOUT HERE ]

Using variation in bank distress and deposit flows, we then ask whether unexplained variation in deposit flows predict unexplained variation bank distress? Moreover, given the granularity of our data, we can further ask whether this differs accross depositor types: Are interbank deposit flows better in predicting bank distress than the flows of regular deposits? And, is there variation across time? If there is variation in the predictive power in deposit flows, it implies that depositors are able to discriminate between more and less stable banks. Moreover, to the extent that there is variation in the predictive power across different types of deposits and time, it would imply that some depositors are better informed or more sophisticated than others.

We readily acknowledge an important caveat of our empirical approach. We cannot identify to which extent withdrawals at an individual bank are caused by the prospect of default or to which extent withdrawals are the 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, 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 banks other depositors will conceive as fragile, or both.

### 5.1 Empirical specification

Our empirical strategy uses a method that is similar to the methods developed to identify private information in insurance markets (see, e.g., Chiappori and Salanie, 2000). Our analysis here proceed in two steps. First, we explain deposit flows and bank distress independently by bank balance sheet characteristics. Second, we regress the unexplained variation in bank distress on the unexplained variation in deposit flows. We then test whether the unexplained growth of different types of deposits (interbank vs. regular deposits, demand deposits vs. time deposits) has different predictive power for unexplained variation bank distress in different stages of the run.

Bank balance sheets were public information available to all depositors at the time. Therefore, we start out with studying the cross-sectional variation in bank stability and bank characteristics to identify which characteristics may be determinants of stability during a bank run. Our empirical setup 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).

We thus start out with testing whether bank capitalization and bank liquidity at the onset of the crisis predict deposit flows and bank distress during the crisis. Specifically, we estimate the following model:

$$
\begin{aligned}
y_{b,t} = \tau_t &+ \beta_1 \times \text{Equity}_b \times \text{May 1931} \\
&+ \beta_2 \times \text{Liquidity}_b \times \text{May 1931}_t \\
&+ \beta_3 \times \text{Size}_b \times \text{May 1931}_t \\
&+ \beta_4 \times \text{Foreign Deposits}_b \times \text{May 1931}_t \\
&+ X_{b,t} + \gamma_\theta + \epsilon_{b,t},
\end{aligned} \tag{1}
$$

where $y_{b,t}$ is either the monthly growth rate of deposits, $\Delta D_{b,t}$, or a dummy variable indicating whether the respective bank becomes distressed during the run. Moreover, we distinguish between different types of deposit growth, including total deposits, interbank deposits, regular deposits, time deposits, and demand deposits. Further, $\text{May 1931}_t$ is a dummy that takes the value of one after the Austrian Creditanstalt has failed, i.e., from May 1931 onwards.

$\text{Equity}_b$, $\text{Liquidity}_b$ denote the bank $b$'s capitalization and liquidity mismatch at the onset of the bank run, respectively. We measure a bank's capitalization by using the ratio of bank capital over total bank credit, and a banks liquidity position by the ratio of liquid assets relative to total assets. We choose to calculate 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. [26] $\text{Size}_b$ is the natural logarithm of a banks assets, and $\text{Foreign Deposits}_b$ is bank $b$'s ratio of foreign deposits over total deposits.[27] Further, $\tau_t$ is a time fixed effect, $\gamma_\theta$ is a bank-type fixed effect, and $X_{b,t}$ is a set of control variables, including $\text{Liquidity}_b$, $\text{Size}_b$, etc.

After explaining the variation in deposit flows and bank distress, we then fit the unexplained variation with the unexplained variation in deposit flows. That is, we estimate the following model month-by-month

$$
\widehat{\epsilon_{b,t}}^{\text{Distress}} = \alpha + \gamma \times \widehat{\epsilon_{b,t}}^{\Delta D_{b,t}} + v_b, \tag{2}
$$

where $\widehat{\epsilon_{b,t}}^{\text{Distress}}$ is the residual from estimating Equation (1) when using the bank distress indicator

[26] In our primary specification, we calculate $\text{Equity}_b$ and $\text{Liquidity}_b$ as the average ratios the period between September 1929 and September 1930 and then estimate the Equation (1) using data from October 1930 through March 1932.

[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.

as the dependent variable. Further, $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ is the residual from using deposit growth as the dependent variable. Importantly, we only keep banks in our data before they become distressed and exclude them as of the month of the distress event.

### 5.2 The cross-section of bank distress and deposit flows

Given Equation (1), the effect of equity and liquidity on bank stability during the run is then measured by the coefficient of the interaction of the May 1931-dummy with the respective bank-level characteristic.

Table 1 and Figure 5 give a sense of the variation in pre-crisis bank capitalization and liquidity as of October 1930. For instance, while the average capital ratio—measured as equity over total loans—lies at 20%, banks in the 25th percentile are highly leveraged with a 6% capital ratio in contrast to banks in the 75th percentile which finance 25% of their loans with equity. Similarly, there is considerable variation in the amount of liquid assets held. While on average 15% of all bank assets are liquid, banks in the 25th percentile choose to have only 8% of all their assets to be liquid, compared to 21% in the 75th percentile. [28]

[FIGURE 5 ABOUT HERE]

We start out by estimating Equation (1) using an indicator variable whether a bank becomes distressed throughout the run. The results are reported in column (1) of Table 4 and show the coefficients for bank liquidity, bank equity, size, and foreign deposit funding. Across the board, we find statistically insignificant coefficients, implying that balance sheet characteristics are not good at explaining bank distress.

We then again estimate Equation (1) now using monthly deposit growth as the dependent variable. Column (2) shows that both, equity and liquidity, predict a lower deposit outflow during the crisis. While the average monthly outflow is 2.8 percentage points between October 1930 and March 1932, we estimate that a bank with a one standard deviation higher capital ratio can expect, all else equal, to experience a 0.3 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 0.7 percentage

[28] Recall that 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. A concern with our approach is then that bank capitalization and liquidity holdings are endogenous. 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.

point lower monthly outflow of deposits after the failure of the Creditanstalt. The effects are hence both economically and statistically significant.

[TABLE 4 ABOUT HERE]

Next we turn to estimating Equation (1) distinguishing between the growth in interbank deposits and regular deposits. We find that both types deposit flows are sensitive to bank capitalization with better capitalized banks seing lower outflows in both. In particular, column (3) reveals that interbank deposits fall be less when a bank is better capitalized and column (5) shows that the same is true for regular deposits.

Next we turn to estimating Equation (1) using the monthly time deposit growth as the dependent variable. Results are shown in Column (7) of Table 4. 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 outflow in time deposits are much stronger in magnitude than the overall outflow in deposits: time deposits decrease on average by 3.2 percentage points per month throughout the sample period.

Importantly, as with total deposits growth, bank capitalization and bank liquidity predict lower outflows for time deposits as well. 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 0.9-1.4 percentage points, depending on the specification. Again, the effects are economically and statistically significant, and the effect is somewhat stronger for liquidity.

Finally, we also estimate Equation (1) by using the monthly changes in demand deposits as the dependent variable. Results are shown in Column (8) of Table 4. In line with the aggregate flow of demand deposits, we find that there is little outflow in demand deposits. Demand deposits decrease on average by around 0.7 percentage points per month in the sample period. We neither detect systematic differences across well or less well capitalized banks, nor across less or more liquid banks.

Altogether, the evidence suggests that both bank capitalization and bank liquidity predict lower deposit outflows and hence higher bank stability during the run. In line with aggregate deposit outflows, the effect is driven by a lower outflow in time deposits. Hence, our evidence suggests that, both bank equity and bank liquidity are able to increase bank stability in a system-wide bank run.

### 5.3 Unexplained deposit flows and bank distress

Our findings reveal that there is large heterogeneity in the informativeness of deposit flows different types of deposits and across time. Starting with interbank deposit flow, the upper panel of Table 5 and panel (a) of Figure 6 reveals that a higher unexplained inflow of interbank deposits in April and May 1931 is associated with a lower chance of becoming distressed throughout the run. In particular, a one standard deviation increase in unexplained deposit outflows in April or May 1931 implies an 8 percentage points lower chance of becoming distressed throughout the run. That is, we find that interbank deposit flows are predictive of eventual bank distress in the month before the run starts as well as in the first month of the run, i.e., from March 1931 through May 1931.

[FIGURE 6 ABOUT HERE]

Importantly, bank deposit flows are predicting bank distress *before* aggregate deposits start to contract, indicating that some banks have valuable private information about other banks' future distress. More than that, they use the information even before the run can be detected in the aggregate interbank deposit growth. This finding is in line with banks having the most information about the state of the banking system and being the most sophisticated type of depositors.

Importantly, other types of depositors are also able to discriminate between troubled and non-troubled banks. The lower panel of Table 5 and panel (b) of Figure 6 shows that the flows of deposits become predictive of bank distress during the second phase of the run, when aggregate deposits are contracting at a high rate in June 1931. In particular, a one standard deviation increase in unexplained deposit outflows during June 1931 implies an around 4 percentage point higher chance of becoming distressed.

Furthermore, when considering the maturity of deposit contracts, estimates from Table 6 and panel (c) and (d) of Figure 6 show 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 depositors shortening maturities in the early phase of the run (Brunnermeier and Oehmke, 2013) at banks that are likely to become distressed.

Finally, at the height of the crisis, in July 1931, deposit flows become entirely uninformative of bank distress and depositors cease to discriminate between banks' fundamentals. Both, as the estimates from Table 5 reveal, both flows in interbank and regular deposits have no predictive power for bank distress

during July 1931. Moreover, the same is true when distinguishing between short-term and longer term deposits, see Table 6. Thus, as depositors are withdrawing from all banks equally—irrespective of the whether a bank is ultimately distressed or not—this finding is in line with a system-wide panic in which depositors are attempting to seek safety outside of the banking system.

[TABLE 5 AND 6 ABOUT HERE]

## 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 better 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 very 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 stages of the run and only after the interbank market has started to collapse. Finally, at the height of the crisis, deposit flows are generally uninformative and depositors seek safety not within, but outside of the banking system. This finding is in line with withdrawal decisions being panic-driven and independent of a specific bank's fundamentals.

In line with depositors in part seeking safety within the banking system, we find that both, bank

equity and liquidity predict lower deposit outflow and thus raise bank stability during the run. Our paper thereby provides evidence that both, reducing leverage and liquidity mistmatch in the banking sector may increase overall bank stability. Moreover, in line with models in which bank capital is a key determinant of bank credit provision (see, e.g., Holmstrom and Tirole, 1997; Brunnermeier and Sannikov, 2016), we find that better capitalized banks also cut less credit during the crisis.

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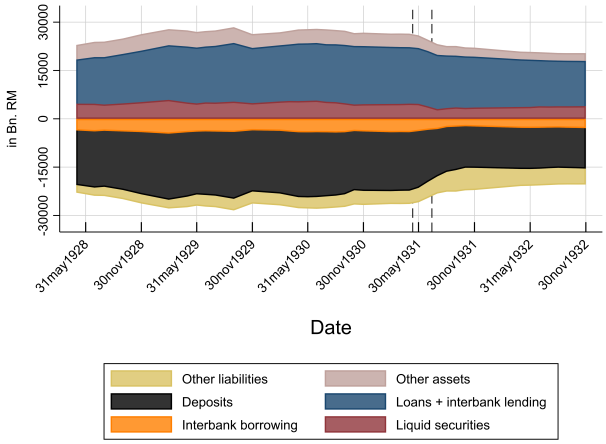
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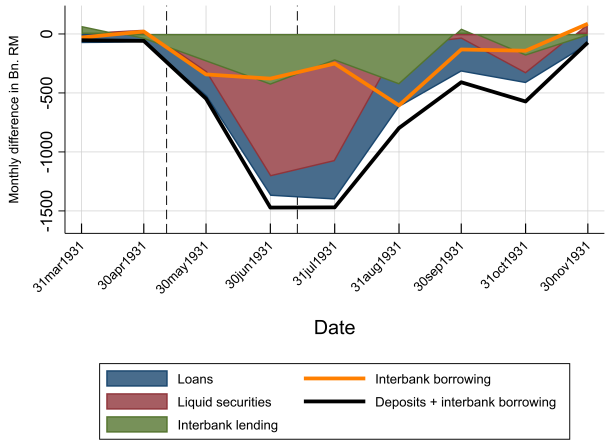
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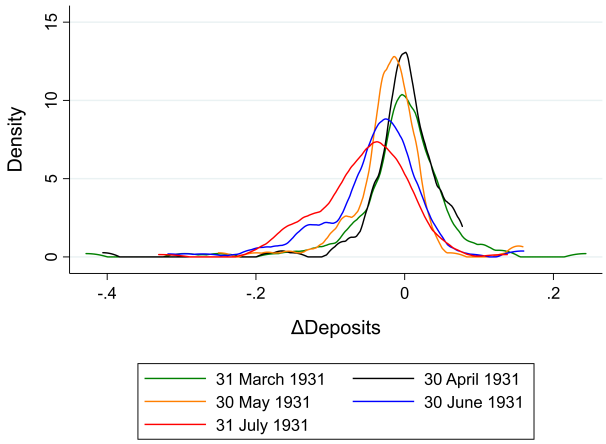
# 7 Figures



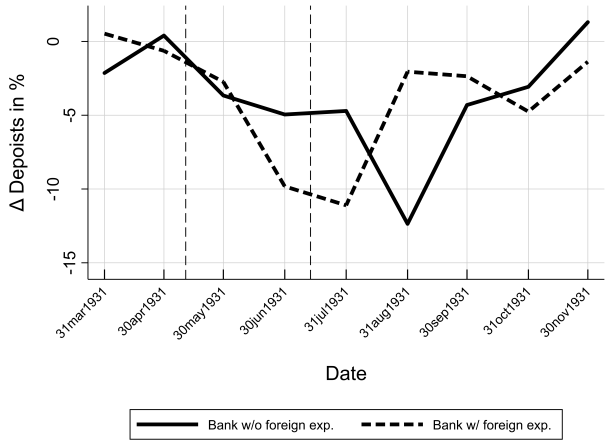

**(a)** *This figure plots the aggregate levels of bank assets, deposits, loans, interbank lending, and liquid securities (cash, treasury bills, corporate securities) on a monthly basis from April 1928 to November 1932.*




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

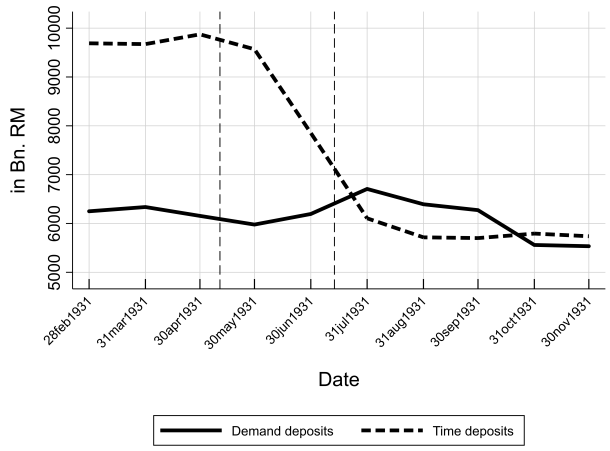



**(c)** *Density of monthly bank-level deposit growth rates from March 1931 to July 1931.* $\Delta Deposits = \frac{Deposits_{b,t} - Deposits_{b,t-1}}{Deposits_{b,t-1}}$.

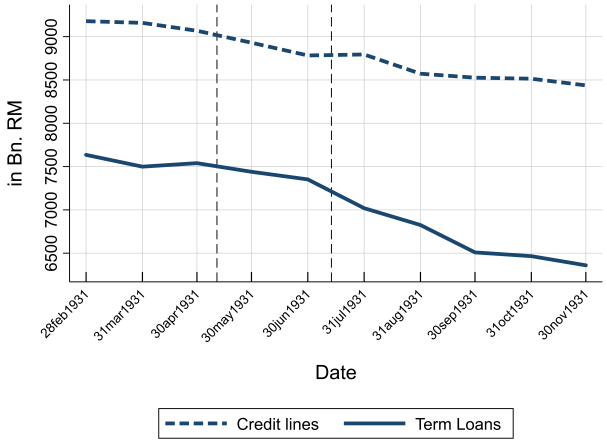



**(d)** *Average month-to-month growth rate of bank-level deposits from March 1931 to November 1931, splitting banks into those that make use of foreign-denominated deposits and those that do not.*

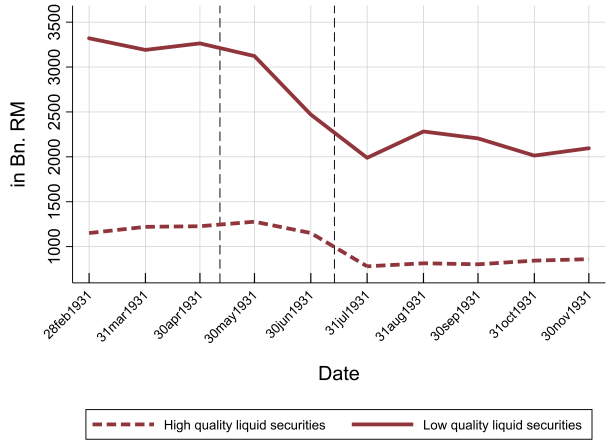
**Figure 1:** ***Aggregate dynamics I.*** *The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, and corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is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



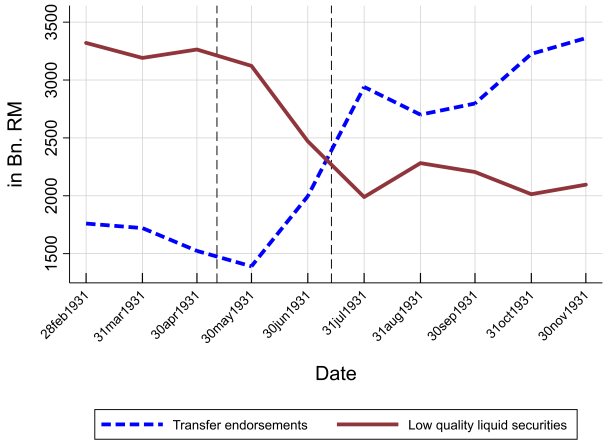

**(a)** *Aggregate levels of time and demand deposits between February 1931 and November 1931.*




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

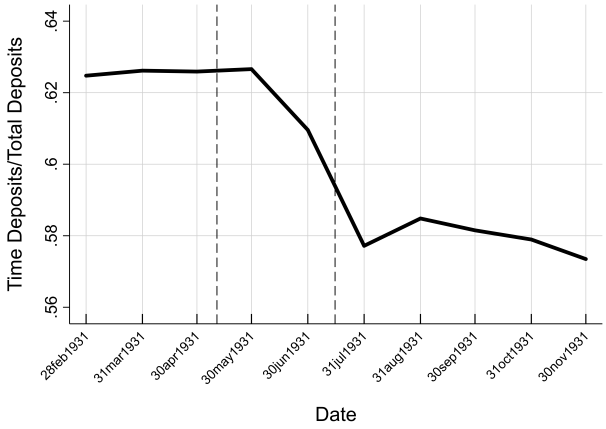



**(c)** *Aggregate levels of "high" and "low" quality liquid securities from February 1931 through November 1931. High quality liquid securities are defined as Treasury's and high quality bills of exchange. Low quality securities are comprised of corporate bonds and municipal bonds.*

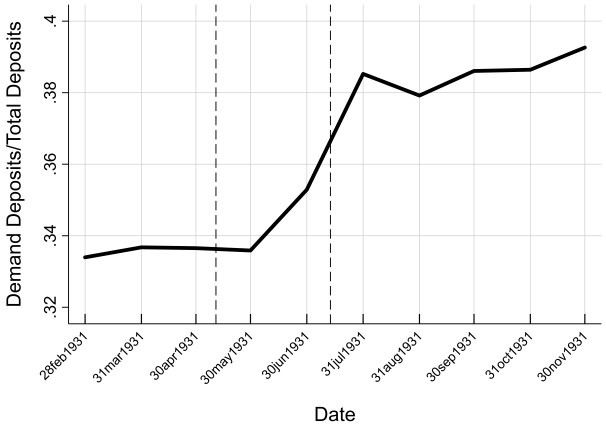



**(d)** *Aggregate levels of "low" quality securities and off-balance sheets transfer endorsements from February 1931 through November 1931. Transfer endorsement are an off-balance sheet liability stemming from retaining the credit risk of a claim sold.*

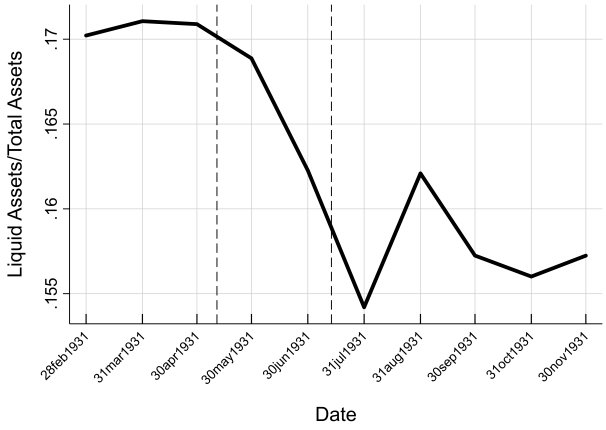
**Figure 2:** ***Aggregate dynamics II.*** *The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is available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



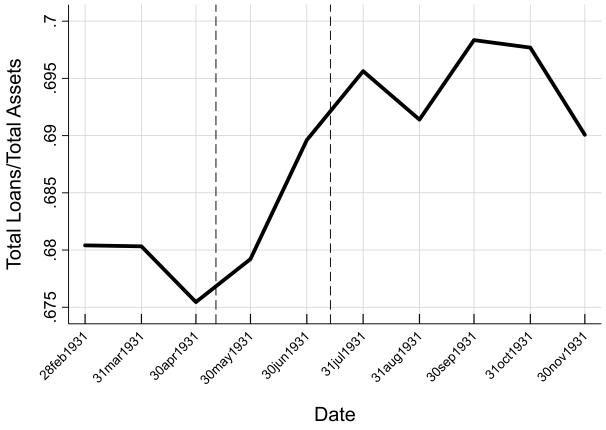

**(a)** *Ratio of aggregate time deposit to total assets between February 1931 and November 1931.*




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

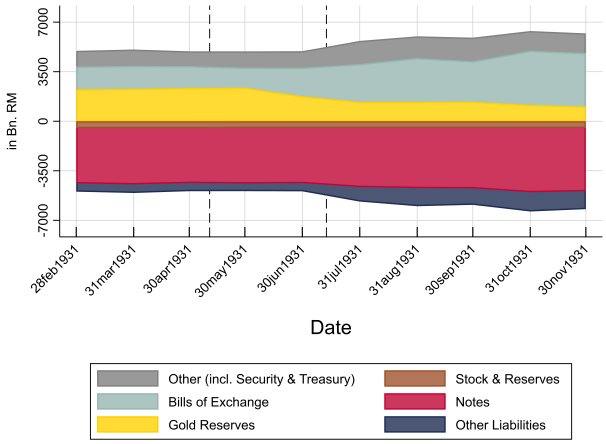



**(c)** *Ratio of aggregate liquid assets to total assets between February 1931 and November 1931.*

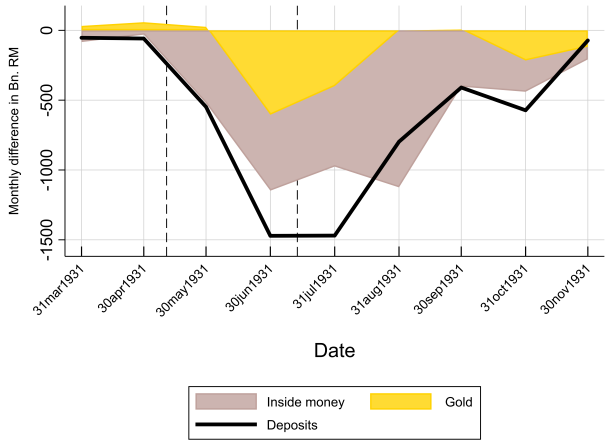



**(d)** *Ratio of total loans to total assets between February 1931 and November 1931.*

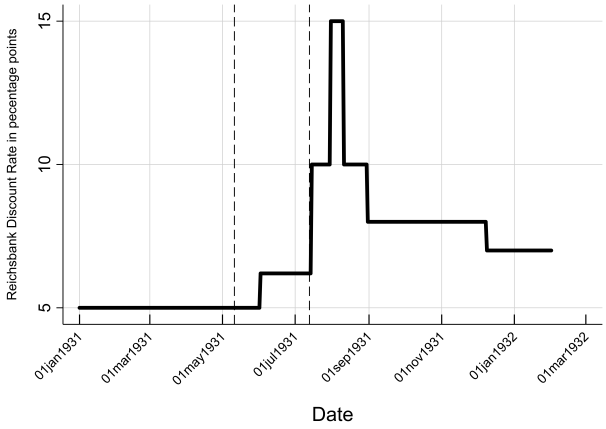
**Figure 3:** ***Aggregate dynamics III.*** *The first vertical line, on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line on July 13, 1931, corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January.*



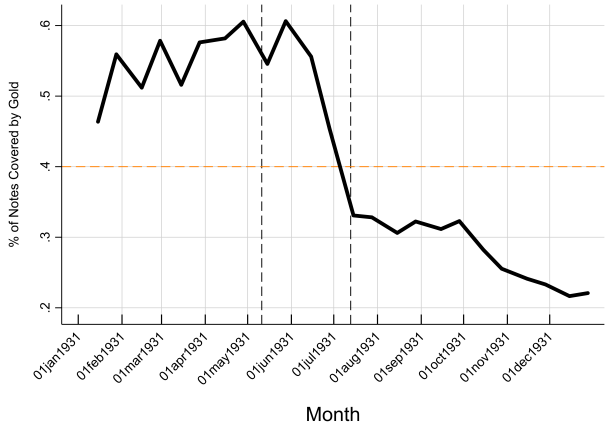

**(a)** *Evolution of the Reichsbank's assets and liabilities at a weekly frequency from January 1931 through December 1931.*




**(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.*

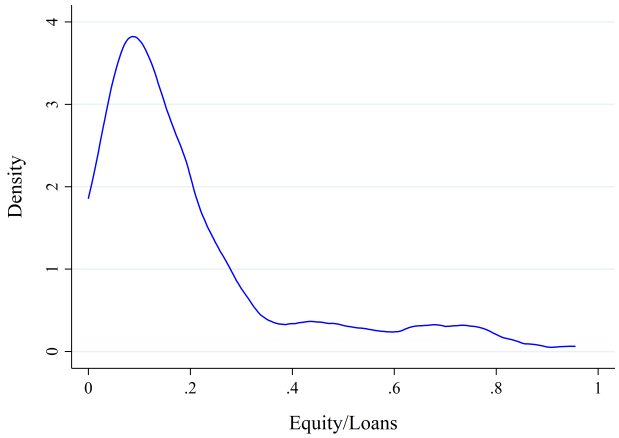



**(c)** *Reichsbank Discount rate between October 1929 and January 1932.*

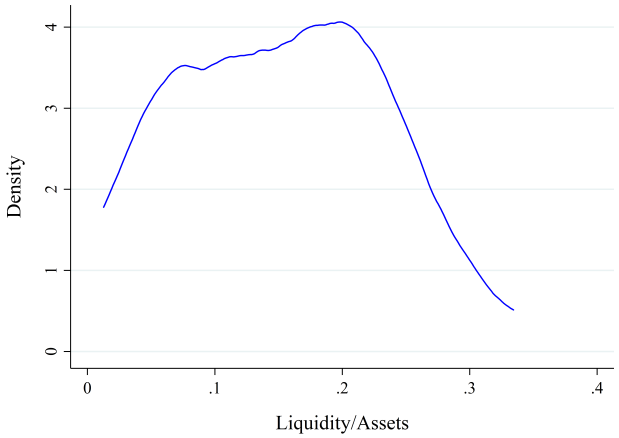



**(d)** *Ratio of outstanding notes relative to Reichsbank gold reserves. Horizontal line marks the 40% minimum gold coverage ratio.*

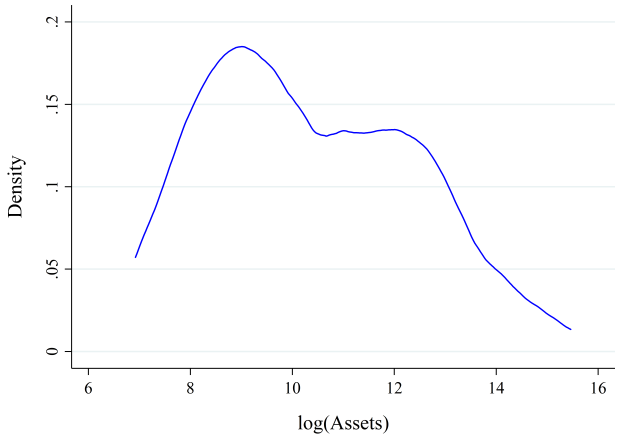
**Figure 4:** ***Reichsbank during the crisis*** *The first vertical line is on May 11, 1931, marks the date of the failure of the Austrian Creditanstalt. The second vertical line, on July 13, 1931, corresponds to the failure of the German Danatbank and Dresdner Bank. Note that bank balance sheet data is available at a monthly frequency, excluding December and January, Reichsbank balance sheet data is available at a weekly frequency, and the discount rate is available at a daily frequency.*



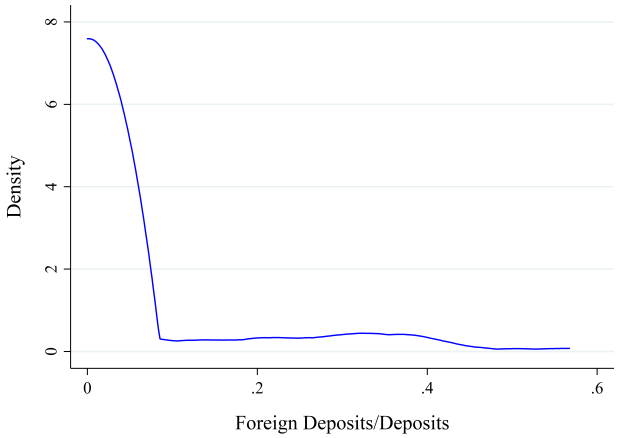

**(a)** *Leverage.*




**(b)** *Liquidity.*

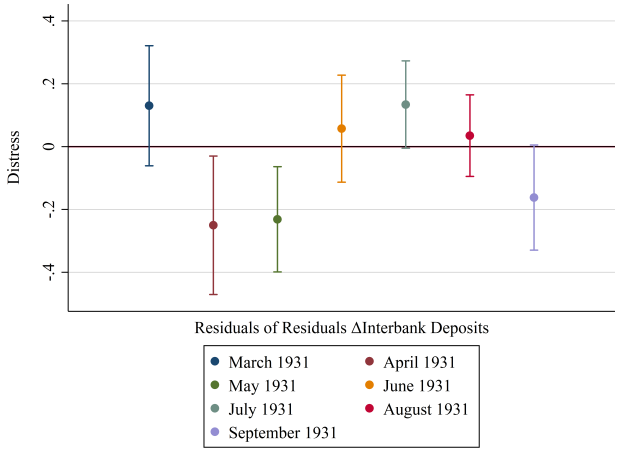



**(c)** *Size*

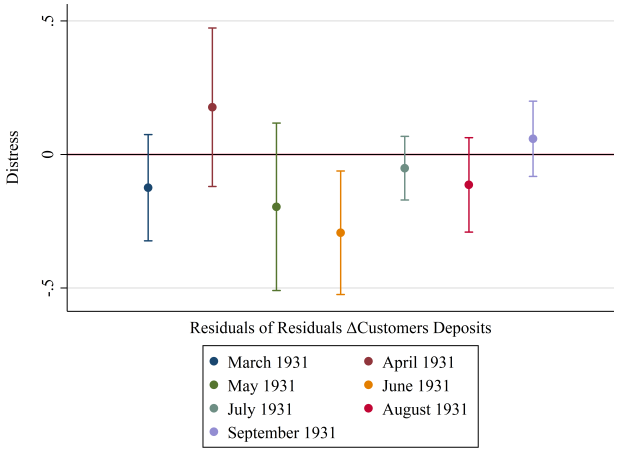



**(d)** *Foreign Deposits.*

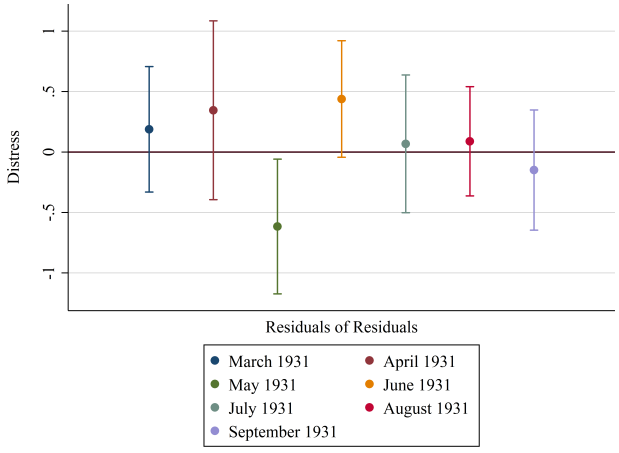
**Figure 5:** *This figure plots kernel densities for the ratio of bank equity to total credit, liquid assets to total assets, the logarithm of total assets and the ratio of foreign deposit to total deposits. The ratio's are calculated as the bank-level average between September 1929 and September 1930. Data are restricted to banks reporting balance sheets reported in October 1931.*



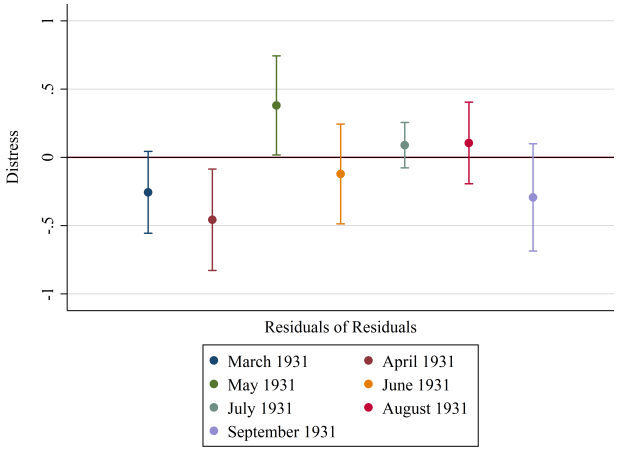

**(a)** *Interbank deposits.*




**(b)** *Regular deposits.*




**(c)** *Time deposits.*




**(d)** *Demand deposits.*

**Figure 6:** *This figure reports coefficients from estimating the following model month-by-month* $\widehat{\epsilon_{b,t}}^{Distress} = \alpha + \gamma \times \widehat{\epsilon_{b,t}}^{\Delta D_{b,t}} + v_b$*, where* $\widehat{\epsilon_{b,t}}^{Distress}$ *is the residual from estimating Equation* (1) *when using the bank distress indicator as the dependent variable. Further,* $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ *is the residual from using deposit growth as the dependent variable. We only keep banks in our data before they become distressed and exclude them as of the month of the distress event.*

# 8 Tables

**Table 1:** ***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 2:** *Comparison of banks*

| Bank | Event Date | Event |
|---|---|---|
| Bankhaus Buehl | May 1931 | Default |
| Hansabank Oberschlesien A.-G. | May 1931 | Default |
| Gewerbebank AG | June 1931 | Distressed merger |
| Dresdner Bank | July 1931 | Bail out |
| Allgem. Deutsche Kredit-Anstalt | July 1931 | Bail out |
| Darmstaedter und Nationalbank | July 1931 | Distressed merger |
| Landesbank d. Rheinprovinz | July 1931 | Bail out |
| Hallescher Bankverein v. Lullisch, Kaempf u. Co., K. a. A. | August 1931 | Bail out |
| Leipziger Kredit-Bank | September 1931 | Bail out |
| Bank fuer Handel und Gewerbe | September 1931 | Default |
| Leipziger Immobilienges. Bk. Grundbesitz A.-G. | September 1931 | Default |
| Rheinische Bauernbank A.-G. | October 1931 | Bail out |
| Hollandische Kreditbank AG | October 1931 | Default |
| Vorschuss- u. Spar-Vereins-Bk. In Luebeck | November 1931 | Default |
| Commerz-Bank in Luebeck | December 1931 | Bail out |
| Anhalt-Dessauische Landesbank | December 1931 | Distressed merger |
| Deutsche Bank | February 1932 | Bail out |
| Wernigeroeder Bank | February 1932 | Default |
| 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, were, bailed out, or merged by government intervention during the crisis.

**Table 3:** *Statistics for individual banks*

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

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 change from September 1930 to September 1931.

**Table 4:** ***Bank distress and deposit flows in the cross-section*** *— Data from October 1930 and March 1932.*

| Dependent variable | Distress | ΔDeposits | ΔInter | ΔInter > 0 | ΔCust | ΔCust > 0 | ΔTime | ΔDemand | ΔCredit |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Equity$^{mean}$ × May 1931 | -0.017 | 0.012** | 0.072*** | 0.121*** | 0.057*** | 0.223*** | 0.026* | 0.005 | 0.028** |
| | (0.028) | (0.005) | (0.027) | (0.039) | (0.014) | (0.042) | (0.013) | (0.018) | (0.011) |
| Liquidity $^{mean}$ × May 1931 | -0.001 | 0.063* | -0.155 | -0.641* | 0.016 | 0.315 | 0.068 | -0.055 | -0.026 |
| | (0.169) | (0.033) | (0.184) | (0.329) | (0.122) | (0.286) | (0.051) | (0.072) | (0.037) |
| Size$^{mean}$ × May 1931 | 0.016** | -0.003* | -0.025*** | -0.048*** | 0.009 | 0.039** | -0.008*** | 0.002 | 0.004*** |
| | (0.007) | (0.002) | (0.007) | (0.013) | (0.006) | (0.015) | (0.003) | (0.003) | (0.001) |
| Foreign Deposits $^{mean}$ × May 1931 | -0.052 | 0.008 | 0.135 | 0.119 | -0.075 | -0.057 | 0.023 | 0.139* | -0.042** |
| | (0.066) | (0.023) | (0.100) | (0.228) | (0.080) | (0.201) | (0.051) | (0.078) | (0.020) |
| Mean | .14 | -.028 | -.027 | .43 | -.016 | .36 | -.031 | -.015 | -.0092 |
| $R^2$ | .14 | .18 | .053 | .061 | .026 | .084 | .16 | .062 | .13 |
| N | 1557 | 1310 | 1297 | 1297 | 1235 | 1235 | 1310 | 1299 | 1310 |
| No of Banks | 131 | 130 | 129 | 129 | 126 | 126 | 130 | 129 | 130 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| BankType FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank FE | No | No | No | No | No | No | No | No | No |
| BankType-Time FE | No | No | No | No | No | No | No | No | No |

This table reports results from estimating

$$y_{b,t} = \tau_t + \beta_1 \times \text{Equity}_b \times \text{May 1931} + \beta_2 \times \text{Liquidity}_b \times \text{May 1931}_t + \beta_3 \times \text{Size}_b \times \text{May 1931}_t + \beta_4 \times \text{Foreign Deposits}_b \times \text{May 1931}_t + X_{b,t} + \gamma_\theta + \epsilon_{b,t},$$

where $y_{b,t}$ is either the monthly growth rate of deposits, $\Delta D_{b,t}$, or a dummy variable indicating whether the respective bank is becomes distressed during the run. Moreover, we distinguish between different types of deposit growth, including total deposits, interbank deposits, regular 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. The model is estimated using data from October 1930 through March 1932. Robust standard errors clustered at the bank level in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

**Table 5:** ***Unexplained Deposit Flows and Bank Distress—*** *Data from October 1930 and March 1932.*

| 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) |
| $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ | 0.130 | -0.250* | -0.232** | 0.057 | 0.134 | 0.035 | -0.162 |
| | (0.116) | (0.134) | (0.102) | (0.104) | (0.084) | (0.079) | (0.102) |
| N | 119 | 118 | 119 | 116 | 111 | 114 | 110 |
| $R^2$ | .0093 | .033 | .029 | .0024 | .022 | .0012 | .027 |
| | Customer Deposit Flows | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ | -0.124 | 0.177 | -0.196 | -0.293** | -0.051 | -0.114 | 0.059 |
| | (0.121) | (0.180) | (0.191) | (0.140) | (0.073) | (0.107) | (0.086) |
| N | 115 | 112 | 113 | 109 | 105 | 107 | 103 |
| $R^2$ | .0024 | .0053 | .0063 | .027 | .00067 | .0039 | .0009 |

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

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

where $\widehat{\epsilon_{b,t}}^{\text{Distress}}$ is the residual from estimating Equation (1) when using the bank distress indicator as the dependent variable. Further, $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ is the residual from using deposit growth as the dependent variable. 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.

**Table 6:** ***Deposit Flows and Default—*** *Data from October 1930 and March 1932.*

| Dependent variable | $\widehat{\epsilon_{b,t}}^{\text{Distress}}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| Date | March 1931 | April 1931 | May 1931 | June 1931 | July 1931 | August 1931 | September 1931 |
| | Time Deposit Flows | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ | 0.188 | 0.345 | -0.616* | 0.439 | 0.068 | 0.088 | -0.149 |
| | (0.315) | (0.450) | (0.339) | (0.293) | (0.347) | (0.275) | (0.302) |
| N | 121 | 120 | 120 | 117 | 112 | 115 | 111 |
| $R^2$ | .0025 | .0037 | .014 | .015 | .00058 | .00059 | .0043 |
| | Demand Deposit Flows | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ | -0.256 | -0.457** | 0.381* | -0.122 | 0.089 | 0.106 | -0.293 |
| | (0.182) | (0.226) | (0.220) | (0.222) | (0.101) | (0.182) | (0.239) |
| N | 117 | 119 | 119 | 116 | 100 | 114 | 110 |
| $R^2$ | .0093 | .029 | .016 | .0025 | .0081 | .0027 | .018 |

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

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

where $\widehat{\epsilon_{b,t}}^{\text{Distress}}$ is the residual from estimating Equation (1) when using the bank distress indicator as the dependent variable. Further, $\widehat{\epsilon_{b,t}}^{\Delta D_{b,t}}$ is the residual from using deposit growth as the dependent variable. 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.