Liquidity from Two Lending Facilities

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December 28, 2017

Abstract

During financial crises, central banks use emergency lending facilities to provide liquidity to the banking sector. Using an unexpected leak of bank names that confidentially borrowed from one of two lending facilities during the Great Depression, we develop a model of banks' endogenous choice of facility to evaluate whether banks used their assistance to meet funding needs. We find that banks' choice of facility after the leak allowed market participants to identify banks most desperate for emergency assistance. We shed light on how to design lending facilities that attract banks that are less likely to use emergency assistance for excessive risk-taking.

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1 Introduction

The Federal Reserve acts as the lender of last resort (LOLR) to provide critical liquidity to the banking sector through its main emergency lending facility, the discount window (DW) (Armantier et al., 2015). The DW was designed to alleviate funding stresses in the banking sector, thereby lessening a "credit crunch" to the real economy.

Traditional LOLR theory suggests that banks should borrow from their LOLR to stop runs, and that the monetary authority should lend unsparingly at a penalty rate (Bagehot, 1873). However, the very presence of the LOLR may create moral hazard incentives for banks to increase their risk-taking because of their access to emergency assistance (Mishkin and Serletis, 2013). Then, LOLR lending facilities may increase overall systemic risk in the financial system, rather than ease funding constraints. Thus, a challenge for policymakers is lending only to banks that are less likely to use their assistance for excessive risk-taking.

During the recent financial crisis, banks were reluctant to borrow from the DW because if their identities somehow became known, market participants would infer this information as a signal of weakness – the so-called stigma problem (Bernanke, 2009; Ennis and Weinberg, 2013). Indeed, if banks were revealed to have received LOLR assistance, they would experience deposit withdrawals and their lending would contract (Anbil, 2017; Vossmeyer, 2017). To alleviate this stigma problem, the Federal Reserve created the Term Auction Facility (TAF) because bank participation at the DW was very low (Armantier et al., 2015). Because a bank's decision to borrow from a facility was likely correlated with its own funding needs, the presence of two facilities made it difficult for policymakers to ex-ante identify those banks less likely to use emergency assistance for excessive risk-taking.

In this paper, we use an unexpected information revelation from the Great Depression, where confidential bank loans from one of two emergency lending facilities were leaked to the public, to examine why banks borrowed from their LOLR and how they used their emergency assistance. This revelation shocked banks' choice of facility, allowing us to examine how their choice of facility was associated with their funding preferences. Our findings shed light on how to design lending facilities that achieve three objectives: (1) ease funding constraints,

(2) are least subject to a stigma problem, and (3) attract banks that are less likely to use emergency assistance for excessive risk-taking.

The Great Depression was the worst financial crisis in U.S. history during which LOLR lending was considerable (Bernanke, 1983). At the time, two lending facilities were available to provide loans to banks – the Reconstruction Finance Corporation (RFC) and the Federal Reserve's DW. Banks could confidentially borrow from either facility or both, and the operations of both facilities were similar. However, identities of banks that had confidentially borrowed from the RFC were unexpectedly leaked to market participants on August 22, 1932, which introduced a stigma problem at the RFC (Anbil, 2017; Vossmeyer, 2017). We exploit this leak to examine how a bank's ex-post choice of facility was related to its funding preferences.

Using a unique hand-collected data set of balance sheet, DW, and RFC loan information for banks in the Federal Reserve Sixth District from January 1931 to September 1934, we develop a trivariate choice-performance model to estimate the effect of the information revelation on banks' choice of facility and their subsequent liquidity condition. A joint model is necessary because banks nonrandomly chose which facility to approach in a way that is endogenous with their risk preferences and funding needs. Additionally, we employ a panel data approach to examine the effect of the leak on banks' balance sheet composition well after the leak occurred. To the best of our knowledge, the combination of DW and RFC loan information makes our paper the first to study the entirety of LOLR lending to financial intermediaries during a crisis.

We find that the pool of banks that approached both lending facilities separated into three groups after the revelation. In particular, one group of banks continued to borrow from the stigmatized facility (RFC), one group switched away from the stigmatized facility, and the last group avoided the facility completely. Through banks' choice of facility after the revelation, market participants could identify those banks that were most desperate for emergency assistance. We find that banks that continued to borrow from the stigmatized facility decreased their position of safe assets by 8.5 percentage points, wrote down their

bond portfolio by 5.2 percentage points, and contracted their lending to the real economy by 5.8 percentage points, in comparison with banks that avoided the facility altogether. These banks were more desperate for emergency assistance than banks that switched away from the stigmatized facility. Because these banks were willing to risk their identities being leaked, their ex-post choice of facility exposed this desperation to the public. Prior to the revelation, it was difficult to determine if funding needs or risk preferences were driving banks' decision to borrow from their LOLR because all banks pooled together.

Altogether, our results imply that the presence of two lending facilities, where one guarantees anonymity while the other does not, might separate banks in a way that reveals their liquidity condition to market participants. For policymakers, this information is extremely meaningful because a crucial concern when designing a lending facility is to attract solvent yet illiquid banks that would continue lending to the real economy. Hence, the presence of of two lending facilities that forces banks to separate according to their liquidity condition may achieve these goals. The facility with no stigma would reduce the ex-ante concern that LOLR assistance goes to less liquid banks. Our results shed light on how policymakers can use the existence of two facilities to classify banks based on their liquidity preferences.

Our paper contributes to several strands of the literature, one of which is a growing theoretical literature on how adverse selection affects markets. Bajaj (2017) shows that a negative shock to the quality of a no-information pooling equilibrium implies a switch to an information revealing separating equilibrium. Our paper provides empirical evidence of this switch because the unexpected leak of bank names caused a negative shock to the design of the RFC. This led banks to separate into groups where their ex-post choice of facility revealed information about their liquidity condition to market participants. Prior to the leak, banks pooled together, providing little information to policymakers about each bank's funding condition.

Our paper also relates to the literature about why banks approach their LOLR. Drechsler et al. (2016), Carpinelli and Crosignani (2017), and Acharya et al. (2016) all shed light on the type of bank that may be prone to excessive risk-taking. Acharya et al. (2016) find

that it was difficult for the ECB to separate solvent but illiquid banks from those prone to excessive risk-taking during the European sovereign debt crisis, while Drechsler et al. (2016) show that weakly capitalized banks took out more LOLR loans and used riskier collateral than strongly capitalized banks during the same period. Similarly, Carpinelli and Crosignani (2017) find that banks that experienced a significant negative shock used their funding to restore credit supply, instead of reaching for yield by buying high-yield government bonds. All three papers highlight the difficulty central banks face trying to ex-ante separate banks that are most likely to use emergency assistance for excessive risk-taking. We contribute to this literature by providing insight on how to design lending facilities that make it easier for policymakers to rank banks based on their liquidity condition before emergency assistance is authorized.

Finally, our paper also relates to the literature about the impact of LOLR loans on the real economy. Benmelech et al. (2017), Sumit et al. (2015), and Alves et al. (2016) all find evidence that LOLR interventions were effective in preventing the collapse of various markets. Benmelech et al. (2017) find that the collapse of the asset-backed commercial paper market during the recent crisis could have been prevented by LOLR interventions. Similarly, Alves et al. (2016) find that unlimited access to emergency assistance in Portugal during the European sovereign debt crisis allowed banks to maintain lending to the real economy. However, Sumit et al. (2015) find that banks are less likely to lend to borrowers that most need funding during a financial crisis, which may limit the effectiveness of LOLR lending facilities. We contribute to this literature by providing evidence that a confidential lending facility may attract banks less desperate for emergency assistance, and these banks are more likely to use their assistance to maintain their lending to the real economy during a financial crisis.

The remainder of the paper is organized as follows. Section 2 describes the RFC and DW facilities, and details the information revelation. Section 3 describes the data and summary statistics. Section 4 presents the trivariate and panel data models. Section 5 presents the results for both of the methodological approaches. Finally, Section 6 discusses

the implications for future LOLR facilities and concludes.

2 Historical Background

2.1 The Reconstruction Finance Corporation and the Discount Window

In response to an acceleration of bank suspensions after Britain left the gold standard in 1931, President Hoover created the RFC (Olson, 1977). The RFC began privately authorizing loans on February 2, 1932 to several types of institutions including commercial banks, insurance companies, and building and loan associations.[1]

The DW, on the other hand, was only available to particular banks. At the end of 1931, only 39 percent of banks were eligible to borrow from the DW at the Fed (henceforth referred to as "member banks"). There were 18,734 banks operating in the United States as of June 30, 1932. Of these banks, 7,246 were Federal Reserve member banks (FRB, 1959, 1932). Mitchener and Richardson (2016) show that the withdrawal pressures of nonmember banks on member banks magnified liquidity risk during the Great Depression. If all banks had been member banks, systemic withdrawal pressures would have been substantially lower (Calomiris and Mason, 2003; FRB, 1932).[2] As a result, President Hoover argued that another facility was needed to provide emergency liquidity assistance to the remaining nonmember banks (Olson, 1977). The RFC Act was submitted to Congress on December 7, 1931, and it was passed into law on January 22, 1932. Forty-four percent of all banks received loans from the RFC by June 30, 1933.

Upon the RFC's establishment, the RFC and DW operated similarly. Each facility was engaging in collateralized lending and Eugene Meyer was both the chairman of the Federal Reserve and the RFC. Thus, not only were the operations similar, but the staffing was as well. There were three differences between the RFC and the Federal Reserve's DW. First, the RFC interest rate was 1.5 to 2 percentage points higher than that of the Federal Reserve's.

[1] Of the total amount of bank loans requested from the RFC, 80 percent were granted.

[2] National banks were Federal Reserve members, as well as some state banks. See Calomiris et al. (2015) for more discussion on the decision to become a member bank.

The discount rate averaged 3.5 percent across Federal Reserve Districts (FRB, 1932). In addition, the term structure of loan interest rates at both the DW and RFC was flat. Second, DW loans were offered for shorter durations than RFC loans. RFC loans were given with maturities up to six months, but banks could easily roll over their loans for an additional two years (Mason, 2001b; RFC, 1932). DW loan maturities ranged from one month to one year. Third, the RFC may have had more discretion with its collateral requirements than the Federal Reserve based on bank examiner commentary in RFC loan applications. Both facilities accepted the same types of collateral which included gold, Treasury securities, and commercial, industrial, and agricultural paper (FRB, 1932; Olson, 1977). However, the RFC did demand a bank's best-quality, most-liquid assets and could demand haircuts of up to 80% unlike the DW (Mason, 2001a,b). By the end of 1932, 6,865 eligible institutions (banks and nonfinancial firms) had been authorized over $1.6 billion in loans by the RFC (RFC, 1932). At the DW, over $6 billion in loans were authorized in 1932.[3] These facts highlight the significance of the RFC and DW and their effect on the financial system.

In this paper, we only focus on member banks because nonmembers did not face a facility choice (the RFC was their only option). Member banks in need of emergency assistance had the option of approaching the RFC, the DW, or both. Importantly, our model framework does not require any proportional substitutability between the facilities and, therefore, does not require that the facilities be interchangeable. A powerful advantage of our framework is its flexibility and that it allows for bank choices to be correlated.

We acknowledge that considering the RFC as an LOLR may be controversial. However, this is not a necessary assumption for our results. Since we find that the RFC's policies of loan authorizations were similar to those of the DW, and it was *acting* in a manner that aligns with the role of an LOLR, we use the LOLR terminology. Furthermore, anecdotal

[3]The aggregate amount of loans granted by the DW is likely much larger than the RFC because the RFC was designed to help country banks which were located in more rural areas (Calomiris et al., 2015). Country banks were smaller than the majority of DW member banks, because member banks were mostly National Banks. Unfortunately, we are unaware of how many member banks received DW loans beyond those in the Federal Reserve Sixth District because of data limitations but, by the end of 1932, there were 6,816 banks that were eligible to receive DW assistance (FRB, 1932).

evidence from DW and RFC loan applications suggests that many banks simultaneously applied to both the RFC and the DW, and offered similar reasoning as to why they needed assistance. RFC loan applications cited DW examiner notes before a loan was authorized and vice versa, which suggests that RFC and DW loan officers worked closely together.

For a thorough review of the RFC, see Butkiewicz (1995, 1999), Mason (2001a,b, 2003, 2009), and Calomiris et al. (2013). For more information about the DW during the Great Depression, see Richardson and Troost (2009) and Wheelock (1990).

2.2 Information Revelation Event

The main identification event in this paper is an unexpected information revelation event that leaked bank names that had confidentially borrowed from the RFC. This event introduced a stigma problem at the facility and plausibly exogenously shocked banks' choice of facility.

Initially, the identities of all RFC borrowers (banks and non-banks) were kept secret from the public. Since its establishment, the RFC had used elaborate secret codes to transmit messages to its loan agencies and individual banks (Olson, 1977). However, on July 21, 1932, the Emergency Relief and Construction Act of 1932 (ERCA) amended the original RFC Act to expand the RFC's authority into state and local relief, public works construction, slum clearance, and so on. In this act, Section 201 (b) required that monthly reports of new borrower names be made known to Congress only (RFC, 1932).[4] President Hoover initially planned to veto the bill because of the addition of the last-minute clause but was assured by the Senate majority leader that RFC loans would not be revealed to the public without congressional approval (CFC, 1932). It was decided that the monthly reports of new borrower names would be confidential and held by the clerks of the Senate and the House of Representatives until Congress resumed session in December (RFC, 1932). Despite this decision, on August 22, 1932, South Trimble, the clerk of the House of Representatives, took it upon himself to release a partial list of the identities of banks that accepted new loans

[4]This expansion of ERCA dropped RFC loan rates to 5.5%, relaxed the collateral requirements it could accept against a loan, increased the capital of the RFC by $1.8 billion, expanded the RFC's authority to stimulate agricultural markets, and allowed the RFC to purchase preferred stock in Federal Home Loan Banks charged with rediscounting home mortgages held by building and loan associations (Mason, 2001b).

from the RFC to inform the U.S. public. The list was first published in the *New York Times* and the *Commercial & Financial Chronicle* and coverage of this list was widespread. It is likely that the publication of the list was unexpected given the assurances that no borrower list would be released without congressional approval.

The loan authorization date for a bank determined whether the bank identity was revealed. The first monthly report that was submitted by the RFC to Congress revealed banks that had loans authorized between July 21 and July 31, 1932. Because the ERCA was passed on July 21, this first monthly report was the only one Mr. Trimble had access to. Banks not revealed had a loan authorized on or before July 20, 1932. Because Mr. Trimble published all names available to him on the monthly lists, this suggests he did not choose which banks to reveal in a way that was correlated with bank characteristics. Because Congress was not in session, Mr. Trimble published four additional lists of borrower names following the August 22, 1932 list, finishing on January 26, 1933. The lists included all banks with loans authorized between July 21 and December 31, 1932, and loans over $100,000 authorized between February 2 and July 20, 1932. Banks with loans of less than $100,000 that were authorized before July 20, 1932 remained confidential. In addition, all DW loans remained confidential.[5]

2.3 Hypothoses

Prior to the publication of the list on August 22, 1932, member banks could choose to approach the RFC and/or the DW. In fact, in our sample of banks in the Federal Reserve Sixth District, 85% of banks borrowed at least once from both the DW and RFC before August 22.[6] The interest rate, collateral requirements, and duration of the loan were all known

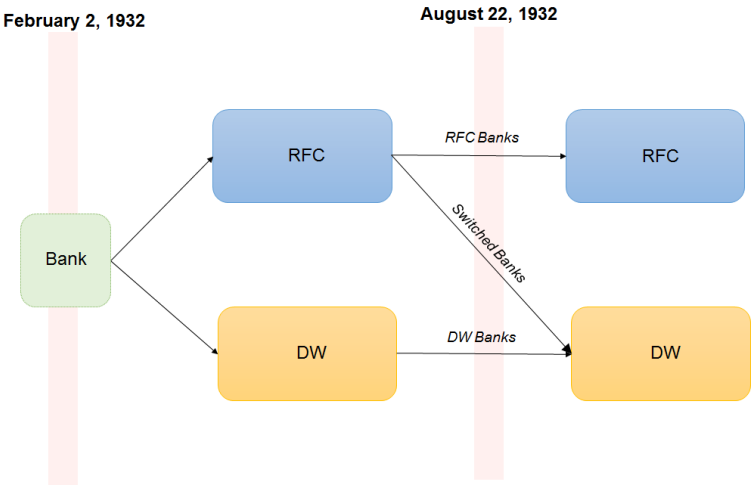
[5]During the recent financial crisis, market participants believed DW borrower identities were leaked in the weekly H.4.1 release by the Federal Reserve that provides the book value of the Federal Reserve's balance sheet including its regional banks. If a bank had borrowed a large amount from their corresponding Federal Reserve regional bank, the aggregate amount lent would be displayed on the regional bank's balance sheet, and be released to the public every Thursday at close of business. Based on the location of the bank, market participants could infer which bank borrowed from their LOLR based on the balance sheet of the local Federal Reserve regional bank.

[6]Our paper is limited to studying banks in the Federal Reserve Sixth District because DW data is only available from this District.

at both LOLR facilities. However, after August 22, a stigma problem was unexpectedly introduced at the RFC, as loan confidentiality could no longer be guaranteed because of the renegade clerk.

After the RFC facility was stigmatized, how did banks' choice of facility change? We split the larger pool of borrowers into three smaller groups: banks that continued borrowing from the RFC ("RFC banks"), banks that switched away from the RFC ("switched banks"), and banks that remained only at the DW ("DW banks"). We focus on these groups because we hypothesize that banks' ex-post choice of facility could be revealing of their liquidity condition in a way that was difficult to identify before the revelation. Figure 1 provides a flow chart that describes this separation of banks into mutually exclusive groups based on their choice of LOLR on or after February 2, 1932 (when the RFC began authorizing loans).

Figure 1: Banks' Choice of LOLR



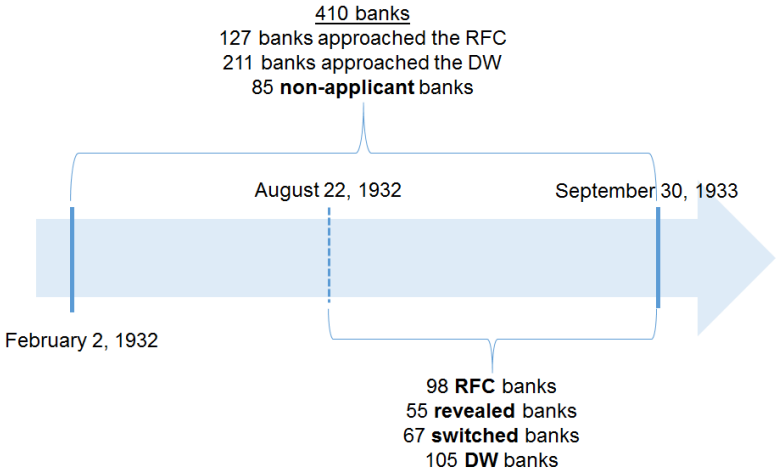
This figure provides a flow chart of a bank's choice of LOLR on or after February 2, 1932 (when the RFC began authorizing loans). After the information revelation on August 22, we refer to banks that continued borrowing from the RFC as "RFC banks", banks that switched away from the RFC as "switched banks", and banks that continued borrowing from the DW as "DW banks".

In order to capture the dynamics of the entire bank population, we also examine banks that never applied to either the RFC or DW for a loan ("non-applicant banks"), and banks that were revealed on a list in the *New York Times* ("revealed banks"). We expect this latter group of banks to endure the largest cost of stigma at the RFC, as the public viewed

the news that a bank borrowed from its LOLR as a sign of financial weakness about the bank (Anbil, 2017; Vossmeyer, 2017).

Figure 2 shows that there were 410 eligible banks in the Federal Reserve Sixth District, where 127 borrowed from the RFC, 211 borrowed from the DW, and 85 non-applicants did not borrow from any LOLR (as of September 30, 1933). There were 98 RFC banks that borrowed from the RFC after August 22, 1932. During the same period, there were 105 DW banks that borrowed from the DW. There were 55 banks revealed on a list in the *New York Times* that had a loan authorized between February 2, 1932 and December 31, 1932. Finally, there were 67 banks that switched away from the RFC to the DW or stopped borrowing altogether after the revelation. These five groups are mutually exclusive and exhaustive, and the performance of these groups are our main focus.

Figure 2: Timeline of the Bank Groups



This figure displays the timeline illustrating how many eligible banks were in the Federal Reserve Sixth District between February 2, 1932 and September 30, 1933. Non-applicant banks were banks that never approached an LOLR during this time period. RFC banks borrowed from the RFC after August 22, 1932. DW banks borrowed from the DW after August 22, 1932. Revealed banks were revealed on a list in the *New York Times* on or after August 22, 1932. Finally, switched banks borrowed from the RFC prior to August 22, but then either switched to the DW or stopped borrowing from the LOLR afterwards.

Before we discuss our testable hypotheses, we provide some necessary background. Why would a bank borrow from the RFC if it could borrow from the DW? First, we can see from RFC loan applications that many banks were encouraged to borrow from the RFC to

increase its validity as an LOLR. Bank presidents may have endured some political pressure to borrow from the RFC. For a review of the political economy of the RFC, see Mason (2003). Second, RFC loans were of slightly longer duration than DW loans, and rolling over loans seemed to be an easier process at the RFC. As a result, rollover risk for RFC loans might have been lower despite the higher interest rate on the loan. Third, the regulatory oversight at the RFC might have been less than at the DW. A bank approaching the RFC for the first time would encounter new regulatory examiners that might have been more accommodative in terms of LOLR policy. We further investigate this question in our choice framework and jointly model the unobservables relating RFC and DW choice.

Why would a bank switch to the DW after the publication of the list? If the bank was more concerned with its depositors discovering that it received LOLR assistance than rollover risk, the bank would seek assistance from the DW. However, if the bank did not have the collateral required to receive a loan at the DW, it might decide to remain at the RFC. Those banks that switched to the DW (switched banks) were more concerned about stigma than rollover risk, and had the necessary collateral to borrow from the DW. However, those banks that stayed at the RFC were more concerned about rollover risk or did not have the necessary collateral to borrow from the DW, although RFC loans had to be fully secured against the highest quality collateral. The presence of two facilities and the sudden information revelation allow us to investigate how banks' ex-post choice revealed their liquidity condition to market participants. Their funding demands were difficult, if not impossible, to disentangle in the setting where banks pooled together at both facilities or only had a single facility.

Hypothesis 1: We expect non-applicant banks to be the most well-capitalized.

The Federal Reserve Bank of Atlanta (Sixth District) was very accommodative with LOLR policy in the United States (Richardson and Troost, 2009). The findings in Richardson and Troost (2009) support the notion that the DW was not stigmatized in this District. The President of the Federal Reserve Bank of Atlanta did not adhere to the Real Bills Doctrine

where the LOLR would only lend to banks against "real" loans as collateral, such as trade contracts with merchants. Accordingly, it is likely that non-applicant banks did not apply for LOLR loans, as they were well-capitalized.

Hypothesis 2: We expect the performance of revealed banks to be the worst.

We expect the performance of revealed banks to be the worst because stigma was costly and present at the RFC (Anbil, 2017; Vossmeyer, 2017). Revealed banks faced deposit withdrawals likely forcing them to sell their most liquid securities to meet depositor demand. Therefore, we expect these revealed banks to be the most desperate for liquid securities and emergency assistance, and their performance to be the most unlike non-applicant banks.

Hypothesis 3: We expect the performance of RFC banks to be slightly better than revealed banks.

RFC bank identities remained confidential. Banks with loans authorized prior to July 21, 1932 with loans less than $100,000 remained classified. These banks that remained confidential would not experience immediate deposit withdrawals due to the publication (Anbil, 2017; Vossmeyer, 2017). Nonetheless, these banks continued borrowing from the RFC without knowing if their identities would be revealed. This behavior suggests that RFC banks were also desperate for funds.[7] As a result, we expect the performance of RFC banks to be slightly better than revealed banks in the Federal Reserve Sixth District.

Hypothesis 4: We expect the performance of switched and DW banks to be the most like non-applicant banks.

Switched and DW banks were unwilling to bear the cost of stigma and valued loan confidentiality over borrowing from the RFC. Consequently, these banks would not experience

[7]We do not observe if banks were rejected from the DW because these data do not exist. Vossmeyer (2016) highlights the importance of modeling declined applications. However, in this case, we observe three banks that approached the RFC that were rejected for loans but then subsequently borrowed from the DW. This suggests that the RFC did not receive all the banks that the DW may have rejected. Additionally, Vossmeyer (2016) examines all RFC borrowers, not just member banks.

immediate deposit withdrawals due to the publication, and should be as well-capitalized as non-applicant banks.

3 Data

3.1 Data Sources

RFC loan information and borrower names are from the *RFC Card Index to Loans Made to Banks and Railroads 1932-1957* acquired from the National Archives. The cards report the name and address of the borrower; the date, request and amount of the loan; whether the loan was approved or declined; and loan renewals. The names of banks revealed to the public are from the *New York Times* and verified in the *Commercial & Financial Chronicle*. These announcements included the loan amounts and interest rates. Loans began on February 2, 1932 and all data are hand-collected.

The DW data are proprietary, have never been seen before, and are from the Federal Reserve Bank of Atlanta Archives. Therefore, our DW data only include banks from the Sixth District, which are the states of Alabama, Florida, Georgia, and portions of Tennessee.[8] The data are from daily ledgers containing loan and collateral amounts outstanding from January 1, 1931 through September 30, 1933. The ledgers report the name and address of the borrower, date, the loan amount outstanding, and the collateral amount outstanding.[9]

Our data include National and State member banks that were eligible to borrow from both the RFC and DW. After February 2, all banks in the sample were eligible to borrow from either LOLR now that the RFC was open. We end the loan sample at September 30, 1933, as that is when our DW data end. Banks that approached the RFC in the Sixth District likely had their loan applications processed in the Texas or DC offices due to these offices' proximity to the Sixth District (Mason, 2003).

Bank balance sheet data are from *Rand McNally Bankers' Directory,* which was published

[8]We do not have data on banks from Mississippi or Louisiana because we think those banks went to the New Orleans Federal Reserve Branch.

[9]Since we do not observe DW flows, we assume that large increases in the loan amount outstanding is a new loan.

every six months. We collect the amounts of paid-up capital, surplus and profits, deposits, other liabilities, loans and discounts, bonds and securities, miscellaneous, cash due from other banks, the name of the president, and bank age for each bank. The data are hand-collected from eight books beginning December 31, 1930 and continuing to September 30, 1934, resulting in eight observations per bank. We also collect bank balance sheet data from the Office of the Comptroller of the Currency. These yearly data include the amount of U.S. Treasury government securities versus other securities on each bank's balance sheet for December 1931, December 1932, and December 1933. Other securities do not include government securities and are likely corporate bonds. For failed banks, we assume total assets and liabilities are zero. We filter out observations where the balance sheet data are identical from period to period, approximately 11 percent of the data. We observe if the bank failed from the *Rand McNally Bankers' Directory* and verify the failure in the *Moody's Directory*.

To account for differing macroeconomic trends and business environments across each county, we include several additional control variables as of December 30, 1930 in our reduced form panel approach and trivariate choice-performance model. We use the dollar amount of total deposits and the total number of banks in each state to account for the size, organization, and resources of the banking system. Next, we use the dollar amount of suspended deposits and the total number of suspended banks in each state to account for the health of the banking system. Suspended banks include both banks that closed their doors to depositors for at least one business day and later resumed operations, and banks that ceased operations, surrendered their charters, and repaid creditors under a court-appointed receiver (Heitfield et al., 2017). The data are from the FDIC Bank Deposit Data, 1920-1936 (Inter-university Consortium for Political and Social Research).

We also include data from the 1930 census of population, manufacturing, and agriculture at the county level to capture cross-sectional changes in a bank's business environment. Finally, we include the number of principal correspondents for each bank as of June 30, 1931 to capture a bank's funding accessibility and its importance to the national network

of banking (Calomiris et al., 2013). These latter data are from the *Rand McNally Bankers' Directory*. A principal correspondent refers to a relationship between banks that is facilitated by deposits of funds (Richardson, 2007).

3.2 Summary Statistics

Table 1 describes summary statistics of RFC, DW, switched, revealed, and non-applicant banks as of December 31, 1931, prior to the publication of the list. The balance sheets of RFC, DW, switched, and revealed banks, which make up the pool of LOLR borrowers, appear remarkably alike. However, non-applicant banks have considerably smaller loans-and-discounts (scaled by total assets) portfolios to those of RFC, DW, switched, or revealed banks. Furthermore, their cash-due-to-banks and bond-and-securities portfolio levels are much higher compared to the other bank groups, suggesting that non-applicant banks exhibited hoarding behavior which provides evidence towards our hypothesis that these banks were the most-capitalized in the Sixth District. Interestingly, many non-applicant banks would approach the RFC by the end of the Depression, particularly after the RFC experienced a regime change and could purchase preferred stock in banks. Finally, Table 1 also confirms the sample selection issues of comparing banks that approached the LOLR to banks that did not, which we are able to control for in our trivariate model.

Figures 3 and 4 display the trends of loans-and-discounts divided by lagged assets and bonds-and-securities divided by lagged assets, respectively, for each group of banks. Figure 3 shows that the loan trend for RFC, DW, and switched banks prior to the revelation was parallel, suggesting that the trends would have continued in this manner were it not for the publication of the list. Similarly, Figure 4 also shows the parallel bond trend for RFC, DW, and switched banks prior to the revelation. These parallel trends help alleviate selection bias with respect to banks' bond and loan positions when we later interpret the coefficients of our reduced form regressions in Section 5.2. Were it not for the publication of the list, we would expect any regression coefficients that compared the loan and bond trends for RFC, DW, and switched banks to be insignificant.

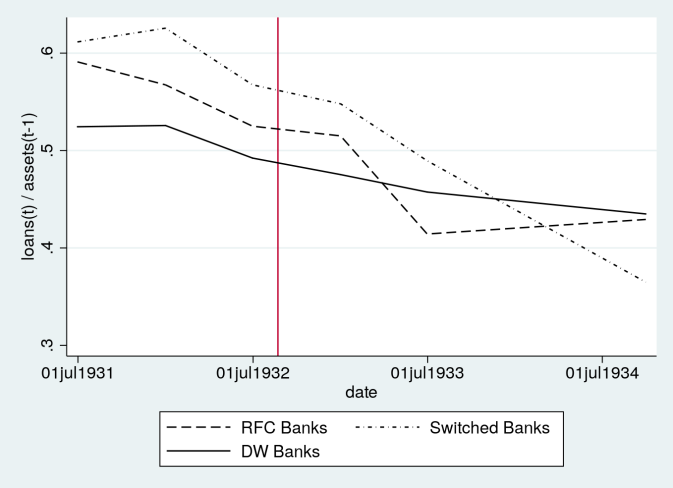
Table 2 provides summary statistics of the average loan amount authorized to RFC, DW, switched and revealed banks. Prior to the publication of the list, RFC banks borrowed from both the RFC and the DW. However, afterwards, RFC banks increased their average loan amounts at the RFC to $101 million from $20.9 million. Further, switched banks dramatically increased their average loan amount from the DW even though these banks borrowed from both the DW and RFC prior to the publication of the list. In fact, switched banks borrowed considerably more from the RFC than RFC banks prior to the publication, suggesting that even though these banks received considerable support from the RFC, they were still willing to switch. Revealed banks continued to borrow mostly from the RFC perhaps because their identities had already been revealed to the public and needed more loans to counter the withdrawals they were facing.

Table 1: Summary Statistics of the Bank Groups

Variable	**RFC**	**DW**	**Switched**	**Revealed**	**Non-Applicant**
No. Banks	98	105	67	55	85
Financial Ratios (averages)					
Cash / Assets	0.13	0.16	0.13	0.12	0.21
Loans / Assets	0.62	0.55	0.64	0.60	0.42
Bonds / Assets	0.19	0.22	0.16	0.20	0.31
Deposits / Liabilities	0.70	0.69	0.67	0.65	0.74
Paid Up Capital / Liabilities	0.10	0.13	0.10	0.10	0.10
County Characteristics (averages)					
Population (×1000)	42.7	58.5	37.8	48.6	54.0
No. Manufact. Est.	51	81	46	56	65
Cropland (×1000 acres)	94.0	87.7	96.8	83.9	81.1
Unemp. Rate	0.043	0.047	0.041	0.046	0.048

This table provides summary statistics for RFC, DW, switched, revealed, and nonapplicant banks. RFC banks approached the RFC after August 22, 1932. DW banks approached the DW after August 22, 1932. Switched banks borrowed from the RFC prior to August 22, 1932, and then switched to the DW or stopped borrowing from an LOLR altogether. Revealed banks were revealed on a list published in the *New York Times*. Non-applicant banks did not approach an LOLR before September 1933. All bank data are as of December 31, 1931 and from the *Rand McNally Bankers' Directory*. All county data are from the 1930 census.

Figure 3: Loan Trend Across Bank Groups



This figure displays loans-and-discounts divided by lagged assets from July 1931 through September 1934 for RFC banks, DW banks, and switched banks. RFC banks borrowed from the RFC after August 22, 1932. DW banks borrowed from the DW after August 22, 1932. Finally, switched banks borrowed from the RFC prior to August 22, but then either switched to the DW or stopped borrowing from the LOLR afterwards.

Table 2: Loan Amount Statistics

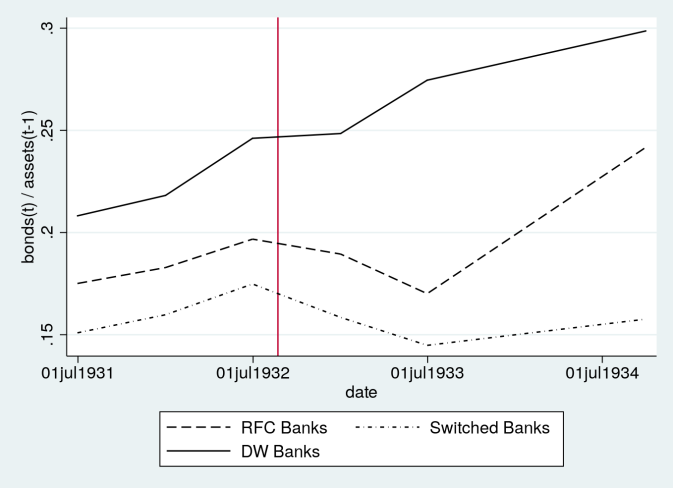
Variable	**RFC**	**DW**	**Switched**	**Revealed**
Averages in millions before August 22, 1932				
RFC loan amount	20.9	0	102.3	145.4
DW loan amount	118.1	69.9	118.9	208.4
Averages in millions after August 22, 1932				
RFC loan amount	101	0	0	193.2
DW loan amount	109.3	128.3	244.1	126.7

This table provides summary statistics for RFC, DW, switched, and revealed banks. RFC banks are those that approached the RFC after August 22, 1932. DW banks approached the DW after August 22, 1932. Switched banks borrowed from the RFC prior to August 22, 1932, and then switched to the DW or stopped borrowing from an LOLR altogether. Revealed banks were revealed on a list published in the *New York Times*. Non-applicant banks did not approach an LOLR before September 1933. All averages are in millions.

4 Methodology

We employ two methodological approaches in this paper: a joint trivariate choice-performance framework and a reduced form panel data approach. The trivariate framework is a system of

Figure 4: Bond Trend Across Bank Groups



This figure displays bonds-and-securities divided by lagged assets from July 1931 through September 1934 for RFC banks, DW banks, and switched banks. RFC banks borrowed from the RFC after August 22, 1932. DW banks borrowed from the DW after August 22, 1932. Finally, switched banks borrowed from the RFC prior to August 22, but then either switched to the DW or stopped borrowing from the LOLR afterwards.

equations that captures a bank's LOLR choice (borrow from both the DW and RFC, borrow from the DW, borrow from the RFC, or do not borrow) and jointly models this choice set with bank liquidity.

In our reduced form approach, the main source of identification is the unexpected publication of bank names that confidentially borrowed from the RFC beginning on August 22, 1932. We analyze the performance of banks after the publication of the list in a panel setting from December 31, 1930 to September 30, 1934.

An advantage of our joint trivariate choice-performance framework is that we can model banks' choice of facility to accommodate concerns of sample selection and endogeneity, because banks do not randomly borrow from LOLR facilities. The framework does not assume independence of facility choice and liquidity, and simultaneously estimates the parameters of the system using a simulation-based algorithm.

The advantage of the reduced form approach is the panel dimension. We can observe

banks' balance sheet composition well before their choice of LOLR facility and also examine the changes to banks' balance sheet composition after the revelation. In addition, the linear specification offers straightforward comparisons between the subgroups of banks.

The sample of banks used in each methodological approach slightly differ. The trivariate choice-performance framework uses only National banks (270 in Alabama, Florida, Georgia, and Tennessee) operating in the Federal Reserve Sixth District as of 1931, including the 85 non-applicant banks. Here, we capture the banking population (those holding a national charter) in these four states, thus controlling for issues involving sample selection bias. The inclusion of only National banks is because of data limitations. We use each bank's position of U.S. government securities as a proxy for its liquidity condition, where a larger position indicates a higher liquidity buffer since U.S. government securities were the preferred choice of collateral in short-term funding markets and at both the RFC and DW. These data are from the OCC's Individual Statements of Condition of National Banks, but are only available for National banks. However, Mason (2001b) and Calomiris et al. (2013) also only use National banks in their sample to assess the effectiveness of the RFC as a LOLR, so these limitations are understood in the literature. Our reduced form approach, on the other hand, include both National and State member banks thus capturing a larger set of LOLR borrowers. However, in this approach, we omit non-applicants to prevent introducing selection bias into the results when comparing the performance of banks that borrowed from a LOLR to banks that did not.

The combination of these methodological approaches and unique data allow us to shed light on whether the information revelation made the DW a more effective LOLR facility than the RFC. In addition, we can cleanly show how a bank's choice of facility is revealing of their liquidity condition. This is an important consideration when designing future LOLR lending facilities.

4.1 Trivariate Choice-Performance Model

As discussed in Section 2.1, the RFC and DW ran emergency lending facilities with publicly known differences in interest rates, loan maturities, and collateral requirements. These differences, along with any other unobservable characteristics, informed banks' choice of LOLR. The choice was not only correlated across the DW and RFC, but it was also related to how the banks used the funds and their subsequent liquidity preferences. Thus, a joint model is necessary, so an independence assumption is not placed on these choices and preferences. Furthermore, the DW was available before the RFC, implying that participation in the DW prior to February 1932 could endogenously drive a bank's choice to approach the RFC.

Motivated by these difficulties, we employ a trivariate model with recursive endogeneity. The framework jointly examines the determinants of a bank's endogenous LOLR choice and its subsequent funding preferences. This model takes into account the nonrandom selection into each facility and the endogenous treatment of LOLR loans. Ignoring these characteristics in a modeling framework could lead to nontrivial biases in the estimation results.

It is important to note that the choice framework in this model does not require any proportional substitution between the facilities. Thus, the econometric model does not make the assumption that the facilities are interchangeable. The setting here is akin to a multivariate probit model, which does not require independence of irrelevant alternatives and allows for multiple choices.[10]

The model is defined by a system of 3 equations:

$$z_{i1} = \boldsymbol{x}'_{i1}\boldsymbol{\beta}_1 + \varepsilon_{i1} \quad (1)$$

$$z_{i2} = \boldsymbol{x}'_{i2}\boldsymbol{\beta}_{21} + +x_{i2,endog}\beta_{22} + \varepsilon_{i2} \quad (2)$$

$$z_{i3} = \boldsymbol{x}'_{i3}\boldsymbol{\beta}_{31} + \boldsymbol{x}'_{i3,endog}\boldsymbol{\beta}_{32} + \varepsilon_{i3} \quad (3)$$

[10]This differs from a multinomial setting where only one choice is made and proportional substitution is required.

for banks $i = 1, \ldots, n$ and $\varepsilon_i \equiv (\varepsilon_{i1}, \varepsilon_{i2}, \varepsilon_{i3}) \sim N_3(0, \mathbf{\Omega})$, where

$$\mathbf{\Omega} = \begin{pmatrix} 1 & \omega_{12} & \omega_{13} \\ \omega_{21} & 1 & \omega_{23} \\ \omega_{31} & \omega_{32} & \omega_{33} \end{pmatrix}. \tag{4}$$

The observed choices $\{y_{i1}, y_{i2}\}'$ are related to the latent data $\{z_{i1}, z_{i2}\}'$ through

$$y_{ij} = \begin{cases} 1 & \text{if } z_{ij} > 0 \\ 0 & \text{if } z_{ij} \leq 0 \end{cases} \tag{5}$$

for $j = 1, 2$, i.e., Equations (1) and (2). For equation (3), the latent data are the observed data $y_{i3} = z_{i3}$. The first observed outcome y_{i1} takes the value 1 if the bank borrowed from the DW and 0 otherwise. The second outcome y_{i2} takes the value 1 if the bank borrowed from the RFC and 0 otherwise. Thus, the set of all possible outcomes for equations (1) and (2) (LOLR choice) is:

$$y_i = \begin{cases} (1,1)' & \text{if the bank borrowed from both the DW and RFC} \\ (1,0)' & \text{if the bank borrowed from the DW and not the RFC} \\ (0,1)' & \text{if the bank borrowed from the RFC and not the DW} \\ (0,0)' & \text{if the bank did not borrow.} \end{cases} \tag{6}$$

Note that the model here has both discrete and continuous outcome variables.[11]

The covariates that enter $\boldsymbol{x}_{i1}$ include the bank's balance sheet information (loans-and-discounts divided by total assets, deposits divided total liabilities, other securities divided by total assets) as of December 31, 1931, and its number of principal correspondents. In Equation (2), the covariates that enter $\boldsymbol{x}_{i2}$ include the bank's balance sheet information as of December 31, 1932 and county information (county population, number of manufacturing establishments, and acreage of cropland). Also included in Equation (2) is $x_{i2,endog}$ which is an indicator of whether the bank borrowed from the DW prior to the establishment of the RFC. This variable is endogenous because it is a function of y_{i1}.

The last equation, Equation (3), captures the bank's subsequent liquidity preferences as of September 30, 1933, and is jointly modeled with LOLR choice. Our measure of bank

[11] Other discrete-continuous models have been used in electricity and transportation research (see, for instance, Dubin and McFadden (1984) and Brownstone and Fang (2014)).

liquidity is the ratio of U.S. government securities divided by total assets.[12] A higher ratio of government securities indicates that the bank has a larger liquidity buffer because these securities were the preferred choice of collateral in short-term funding markets. The covariates that enter $\boldsymbol{x}_{i3}$ include county information (unemployment rate, county population, number of manufacturing establishments, and acreage of cropland) and bank balance sheet information from December 31, 1932 including the age of the bank. The endogenous covariate vector $\boldsymbol{x}_{i3,endog}$ is a set of indicator variables defined by y_{i1} and y_{i2}, and represent the mutually exclusive, exhaustive groups that banks separate into after the publication of the list on August 22, 1932. These groups are: (1) *RFC banks*, (2) *DW banks*, (3) *switched banks*, (4) *revealed banks*, and (5) *non-applicant banks*. These indicator variables will shed light on how each group of banks changed their liquidity preferences after the publication of the list, and revealed their liquidity condition to market participants.

The data support this model specification based on marginal likelihood calculations, which follow from (Chib, 1995; Chib and Jeliazkov, 2001). The covariates selected for each equation follow the findings in Vossmeyer (2016), where the exclusion restrictions are based on information excluded from the RFC loan applications. The examiner commentary in these RFC applications do not include information on bank age or the unemployment rate, so this information is excluded from the RFC equation. These characteristics, however, affect bank liquidity preferences, so we include them in Equation (3). Apparent from the RFC *Paid Loan Files* and *Declined Loan Files*, the RFC examiners often commented on the county in which the bank operated and the financing conditions within the area, which is why this information enters the RFC equation. However, we do not observe this commentary in DW loan applications which is why county characteristic information do not enter into Equation (1). This variable selection framework is formally tested via model comparison in Vossmeyer (2016).

The likelihood function for the three equation system is analytically intractable because of the discrete outcomes in the first two equations and the endogenous covariates. Therefore,

[12]Our results are robust to using cash-due-to-banks divided by total assets as an additional liquidity measure.

estimation relies on simulation-based techniques. However, estimation is further complicated because of the normalizations in the variance-covariance matrix $\boldsymbol{\Omega}$, which are standard in any binary or ordered data setting (Jeliazkov et al., 2008). To overcome these challenges, we implement a Bayesian framework for equations (1) through (5). The model is completed by specifying prior distributions for the parameters. It is assumed that $\boldsymbol{\beta}$ has a joint normal distribution with mean $\boldsymbol{b}_0$ and variance $\boldsymbol{B}_0$ and (independently) $\boldsymbol{\omega} \sim N(\boldsymbol{\rho}_0, \boldsymbol{R}_0)1\{\boldsymbol{\omega} \in S\}$, where S is the set of parameters that produce the positive definite matrix $\boldsymbol{\Omega}$. The complete-data posterior is given by:

$$\pi(\boldsymbol{\beta}, \boldsymbol{\Omega}, \boldsymbol{z}|\boldsymbol{y}) \propto \left(\prod_{i=1}^{n} \left[\prod_{j=1}^{2} 1\{z_{ij} > 0\} \right] N(\boldsymbol{z}_i|\boldsymbol{X}_i\boldsymbol{\beta}, \boldsymbol{\Omega}) \right) \times N(\boldsymbol{\beta}|\boldsymbol{b}_0, \boldsymbol{B}_0) N(\boldsymbol{\omega}|\boldsymbol{\rho}_0, \boldsymbol{R}_0) 1\{\boldsymbol{\omega} \in S\}.$$

The above posterior gives rise to a Markov chain Monte Carlo (MCMC) estimation algorithm. The algorithm is designed particularly for this application and is inspired by other work on multivariate discrete data models (Jeliazkov et al., 2008) and models with restricted covariance matrices (Chan and Jeliazkov, 2009). Furthermore, the algorithm features data augmentation for the sampling of $\boldsymbol{z}$, which follows from Tanner and Wong (1987) and Albert and Chib (1993). Details on the sampler are below, where as a matter of notation, we use "$\backslash k$" to represent all elements in a set except the kth one. Details on the sampler are as follows:

Algorithm 1 *MCMC Estimation Algorithm*

1. *Sample* $[\boldsymbol{\beta}|\boldsymbol{z}, \boldsymbol{\Omega}] \sim N\left(\hat{\boldsymbol{b}}, \hat{\boldsymbol{B}}\right)$, *where* $\hat{\boldsymbol{b}}$ *and* $\hat{\boldsymbol{B}}$ *are given by*

$$\hat{\boldsymbol{b}} = \hat{\boldsymbol{B}} \left(\boldsymbol{B}_0^{-1}\boldsymbol{b}_0 + \sum_{i=1}^{n} \boldsymbol{X}_i'\boldsymbol{\Omega}^{-1}\mathbf{z}_i \right) \quad \textit{and} \quad \hat{\boldsymbol{B}} = \left(\boldsymbol{B}_0^{-1} + \sum_{i=1}^{n} \boldsymbol{X}_i'\boldsymbol{\Omega}^{-1}\boldsymbol{X}_i \right)^{-1}.$$

2. *Sample* $\boldsymbol{\Omega}|\mathbf{y}, \boldsymbol{\beta}, \mathbf{z}$ *using the Metropolis-Hastings algorithm (use* $\boldsymbol{\omega}$ *to produce* $\boldsymbol{\Omega}$*)*

3. *For equations* $k = 1, 2$, *sample* $\mathbf{z}_{ik}|\mathbf{y}, \boldsymbol{\beta}, \boldsymbol{\Omega}, \mathbf{z}_{\backslash k} \sim \mathcal{TN}_{\mathcal{A}_i}(\mu_{k|\backslash k}, V_{k|\backslash k})$ *where* $\mu_{k|\backslash k}$ *and* $V_{k|\backslash k}$ *are the usual conditional mean and conditional variance, respectively. If* $y_{ik} = 0$, $\mathcal{A}_i$ *is* $(-\infty, 0)$, *and if* $y_{ik} = 1$, $\mathcal{A}_i$ *is* $(0, \infty)$.

4.2 Reduced-Form Specification

We use a panel data model to examine the performance and balance sheet composition of the mutually exclusive groups that banks separate into after the publication of the list. This approach utilizes the panel structure of these data, captures before and after effects, and allows for straightforward interpretations and comparisons of the subgroups (we omit non-applicant banks in this analysis).

We estimate the following bank-level linear, panel data model by ordinary least squares (OLS), where t runs biannually from December 31, 1930 through September 30, 1934:

$$Y_{i,t} = \alpha + \beta_1 RFCBank_i \times 1\{t \geq List\} + \boldsymbol{\gamma} X_i \times 1\{t \geq List\} + \eta_t + \delta_i + \epsilon_{i,t}. \quad (7)$$

$Y_{i,t}$ is the outcome of interest measured every six months t for bank i. $RFCBank$ is a dummy equal to 1 if the banks borrowed from the RFC after August 22, 1932 (RFC banks). $1\{t \geq List\}$ is a dummy equal to 1 following the start of list publications on August 22, 1932. The coefficient of interest is β_1, which measures the change in Y_i following the publication of the list for RFC banks in comparison with DW banks.[13] We use three main outcome variables of interest: bonds-and-securities at time t divided by total assets from *t-1*; loans-and-discounts at time t divided by total assets from *t-1*; and cash-due-from-banks at time t divided by total assets from *t-1*. We use these outcome variables as proxies for the performance of each bank. For failed banks, we record zero for these ratios. We scale bonds-and-securities, loans-and-discounts, and cash-and-exchanges by total assets from *t-1* to account for the bank's size, and to ensure the size of the balance sheet is not confounding Y_i contemporaneously. Finally, we run two additional versions of equation (7) to examine the performance of switched banks in comparison with DW banks, and revealed banks in comparison with DW banks.

A key issue that prevents the specifications from identifying the effect of the revelation on $Y_{i,t}$ is that $Y_{i,t}$ may be correlated with unexplained macroeconomic conditions or bank borrower characteristics in the error term $\epsilon_{i,t}$, or both. Therefore, we include controls, $X_i \times 1\{t \geq List\}$ to mitigate this bias where the controls only enter into the specification

[13]Note that we do not include a $1\{t \geq List\}$ dummy nor a $RFCBank$ dummy because they are not identified once we include half-year and bank fixed effects.

after the list is published on August 22, 1932 to ensure the covariates do not confound $Y_{i,t}$ (Barrot, 2016). In addition, X_i is a vector of controls measured at December 31, 1930 which captures the initial condition of the bank's balance sheet well before the list was published to ensure that contemporaneous balance sheet characteristics are not driving our results.

X_i includes the following covariates at the state level: employment rate, per capita income, total deposits, total deposits at suspended banks, the number of banks, the number of suspended banks. X_i also includes the following covariates at the county level: the total population, the number of manufacturing establishments, the total dollar sales of wholesale establishments, the total dollar sales of retail establishments, the amount of crop land, the number of unemployed persons, and the unemployment rate. These covariates are intended to capture observable proxies for macroeconomic conditions and bank characteristics that might explain $Y_{i,t}$, and only enter the specification after $1\{t \geq List\}$ equals 1.

However, the specification may still be biased if some bank characteristics are unobservable. Therefore, we rely on bank fixed effects, δ_i to exclude biases that could result from time-invariant bank characteristics and to capture the extent to which each bank affects $Y_{i,t}$. Additionally, we include half-year fixed effects, η_t to account for time trends in $Y_{i,t}$ eliminating the concern that aggregate changes in $Y_{i,t}$ and the publication of the list occurred together.

Finally, standard errors are clustered at the bank level according to Bertrand et al. (2004). The results are robust to including $Y_{i,t-1}$ as a control variable to account for autocorrelation in the dependent variable (Petersen, 2009). Furthermore, all continuous variables are winsorized at the 1 percent level to avoid outliers driving the estimation results.

5 Results

5.1 Trivariate Choice-Performance Model

Table 3 displays the results for the joint trivariate choice-performance model. Columns DW, RFC, and Bank Liquidity display the results for the system of three equations: Equation (1) that models DW choice, Equation (2) that models RFC choice, and Equation (3) that models

bank liquidity condition, respectively.[14] The below discussion briefly reports the results for each equation and then focuses on the main findings and policy implications.

The results for Equations (1) and (2) help us understand the determinants of RFC and DW choice. The coefficients in the DW and RFC columns demonstrate that the ratio of loans-and-discounts to total assets had a positive effect on banks choosing to borrow from either the DW and RFC. Interestingly, the ratio of other securities divided by total assets is not statistically different from 0 for borrowing from the DW, but is positively associated with borrowing from the RFC. It seems the RFC accepted more non-government securities as collateral than the DW.

Column RFC also displays the results for the county information since this information was important for the choice of borrowing from the RFC according to RFC loan applications. The RFC *Paid Loan Files* and *Declined Loan Files* provide the examiners' reports on each application decision. The examiners often discussed information about the applicant's county and business environment, which is why these variables are being controlled for here. The results demonstrate that county population has a positive effect on borrowing from the RFC, and cropland and manufacturing have a negative effect. These results align with Calomiris and Mason (2003) and Richardson (2007) who find that bank distress is a continuation of agricultural distress.

The endogenous covariate in the RFC equation is "DW, Pre-RFC". The variable is an indicator that takes the value of 1 if the bank accessed the DW in 1931 prior to the RFC's establishment in 1932. The result is positive and statistically different from 0. Accessing the DW in 1931 had a positive effect on borrowing from the RFC in 1932.

Since we cannot interpret the magnitudes of the coefficients in the choice equations because of the non-linear transformation in the model, to further investigate the size of the probability of a bank approaching the RFC given that the bank also received DW assistance, we compute covariate effects. The covariate effect calculation grasps the change in the

[14]The results are based on 11,000 MCMC draws with a burn in of 1,000. Inefficiency factors were computed for the estimated parameters and all are low, implying excellent mixing of the Markov chain. The priors are centered at 0 with a variance of 25.

Table 3: Results for the Trivariate Choice-Performance Model with Recursive Endogeneity.

	DW	RFC	Bank Liquidity
Intercept	0.883 (0.672)	-0.436 (0.687)	0.112 (0.034)
	[-0.44, 2.15]	[-1.82, 0.90]	[0.05, 0.18]
Loans-and-Discounts / Assets	2.868 (0.675)	3.233 (0.633)	
	[1.57, 4.21]	[2.03, 4.49]	
Other Securities / Assets	0.880 (1.10)	3.398 (1.152)	0.199 (0.095)
	[-1.31, 3.01]	[1.20, 5.72]	[0.01, 0.38]
Deposits / Liabilities	-3.046 (0.710)	-3.868 (0.681)	
	[-4.43, 1.63]	[-5.23, 2.60]	
No. Correspondents	0.025 (0.044)		
	[-0.05, 0.11]		
Bank Age			-0.105 (0.055)
			[-0.21, -0.00]
County Population		0.513 (0.249)	
		[0.019, 0.99]	
Manufact. Est.		-0.005 (0.002)	
		[-0.01, -0.00]	
Cropland		-0.336 (0.140)	
		[-0.59, -0.06]	
Unemployment rate			1.430 (0.521)
			[0.40, 2.43]
Endog: DW, Pre-RFC		0.593 (0.234)	
		[0.00, 1.18]	
Endog: RFC Bank			-0.085 (0.029)
			[-0.14, -0.03]
Endog: Non-Applicant			0.069 (0.026)
			[0.02, 0.12]
Endog: Switched			-0.073 (0.061)
			[-0.19, 0.05]
Endog: Revealed			-0.122 (0.029)
			[-0.18, -0.07]

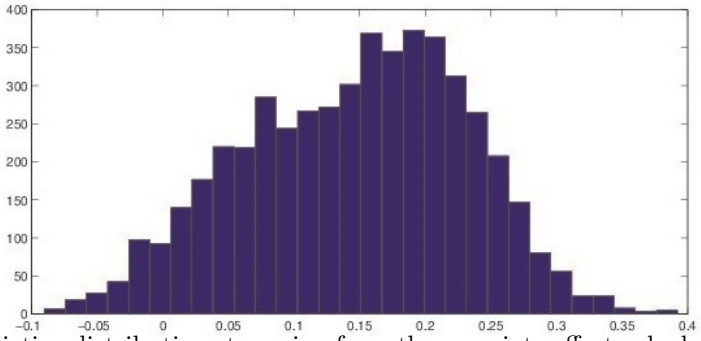
Posterior means, standard deviations (in parentheses), and 95% credibility intervals (in brackets, calculated using quantiles) are based on 11,000 MCMC draws with a burn-in of 1,000. Column DW reflects the results for Equation (1). Column RFC reflects the results for Equation (2). Column Bank Liquidity reflects the results for Equation (3). Endog: DW, Pre-RFC is the estimate for the endogenous covariate $x_{i2,endog}$ in Equation (2). Endog: RFC Bank, Endog: Non-Applicant, Endog: Switched, and Endog: Revealed are the estimates for the endogenous covariates in Equation (3).

probability of receiving RFC assistance between cases when banks did and did not receive DW assistance in 1931. The two vectors $\boldsymbol{X}_i^{\dagger}$ and $\boldsymbol{X}_i^{\ddagger}$ differ only in the value of $\boldsymbol{X}_{i,DW\ \ Pre-RFC}$ and $\boldsymbol{\theta}$ is all model parameters. To understand the magnitude of this result, the covariate effect is averaged over the sample and MCMC draws and is calculated as follows:

$$\delta_{DW,Pre-RFC} = \int [\Pr\left(\boldsymbol{y}_i = 1|\boldsymbol{X}_i^{\dagger}, \boldsymbol{\theta}\right) - \Pr\left(\boldsymbol{y}_i = 1|\boldsymbol{X}_i^{\ddagger}, \boldsymbol{\theta}\right)] f\left(\boldsymbol{X}\right) \pi\left(\boldsymbol{\theta}|\boldsymbol{y}\right) d\boldsymbol{X} d\boldsymbol{\theta}. \quad (8)$$

The covariate effect is 0.146 and a histogram of the probability distribution is displayed in Figure 5. Thus, after controlling for a bank's health, balance sheet, and business environment, borrowing from the DW in 1931 increases the probability of receiving RFC assistance by 14.6 percentage points. The result implies that the LOLR choice is interrelated and is entering banks' random utility function as they maximize.[15]

Figure 5: Covariate effect of DW assistance on RFC assistance.



The figure gives the predictive distribution stemming from the covariate effect calculated from Equation (8), which is a histogram of the MCMC draws. The distribution is centered at 14.6, and the main implication is that assistance from the DW prior to the establishment of the RFC has a positive effect on receiving RFC assistance.

Focusing now on the bank liquidity equation, Equation (3), recall that we measure higher liquidity with more U.S. government securities on the bank's balance sheet. The results show that the unemployment rate in a county had a positive effect on the U.S. government securities held at banks. Thus, banks in areas with higher unemployment rates increased their holdings of safe assets.

[15]This is per McFadden's (1974) initial discussion of the latent utility specification for discrete choice models. See Train (2003) for a review.

The results for the endogenous covariates show the following about the position of U.S. government securities relative to DW banks: (1) revealed banks decreased their holdings the most (−12.2 percentage points); (2) RFC banks also decreased their holdings (−8.5 percentage points); (3) switched banks did not hold statistically different amounts of U.S. government securities; and (4) non-applicant banks increased their holdings (6.9 percentage points). Therefore, revealed and RFC banks reduced their positions of safe assets during a financial crisis, consistent with behavior of banks that were more desperate for funding. Because the information revelation forced banks that were pooling together at the DW or RFC to separate, RFC and revealed banks exposed their poorer liquidity condition to policymakers through their subsequent choice of LOLR. Banks that switched away or avoided the stigmatized facility maintained their position of safe assets, demonstrating their focus on the liquidity of their balance sheet. Finally, non-applicant banks actually increased their position of safe assets during this period providing evidence for *Hypothesis 1.* Non-applicant banks were the most well-capitalized group in the Sixth District. This information would have been difficult to isolate if there existed only one emergency lending facility.

Table 4 presents the posterior means, standard deviations, and implied correlation form for $\mathbf{\Omega}$ which sheds light on how well observable variables can predict a bank's choice of LOLR. ω_{12} represents the covariance between the errors of applying for DW and RFC funding. The implied correlation is positive at 0.159 but the 95 percent credibility interval overlaps zero. This implies that our observable variables are predicting the choice between the DW and RFC well. Recall that the endogenous covariate in the RFC equation, "DW, Pre-RFC", was positive and statistically different from 0, making the joint model necessary for examining the performance of banks based on their choice of facility. The variables we use to control for balance sheet characteristics, county characteristics, and borrowing from the DW before the RFC adequately represent the joint determinants for LOLR choice. This suggests that including these observable characteristics as control variables in our reduced form approach will alleviate some concerns of selection when we further examine bank performance.

Finally, note the positive and significant implied correlations of ω_{13} and ω_{23}. They repre-

sent the covariance between the errors of seeking DW assistance and holding U.S. government securities, and the covariance between the errors of seeking RFC assistance and holding U.S. government securities, respectively. The correlations are of similar size and sign, implying that unobservable variables affect both the relationship between RFC assistance and U.S. government securities versus the relationship between DW assistance and U.S. government securities similarly.

Table 4: Results for $\mathbf{\Omega}$ in the Trivariate Model.

$\mathbf{\Omega}$	ω_{11}	ω_{12}	ω_{22}	ω_{13}	ω_{23}	ω_{33}
Mean	1	0.159	1	0.031	0.033	0.021
Standard Deviation	.	0.236	.	0.011	0.010	0.004
Implied Correlation	1	0.159	1	0.214	0.228	1

Posterior means, standard deviations, and implied correlation form for the estimates of $\mathbf{\Omega}$. Posterior means and standard deviations are based on 11,000 MCMC draws with a burn-in of 1,000. ω_{12} is the covariance between the errors of the choice of RFC assistance and DW assistance. ω_{13} is the covariance between the errors of the choice of DW assistance and the bank's subsequent liquidity condition. ω_{23} is the covariance between the errors of the choice of RFC assistance and the bank's subsequent liquidity condition.

5.2 Reduced Form Approach

We use a panel data approach to examine the response of banks to the publication of the list on August 22, 1932. This model offers a simple interpretations and allows us to examine the changes to bank balance sheet composition after the publication in a panel data setting. We analyze the four groups of LOLR borrowers that banks separated into after the revelation.

First, we determine the probability that a revealed bank continued borrowing from the RFC after its identity was revealed in the *New York Times*. This will provide insights into these banks' desperation of funds, discussed in Section 2.3. Table 5 presents the results. From the OLS regression in Column (1), revealed banks were 52 percent more likely to continue borrowing from the RFC. The covariate effect calculated from the probit model is 47 percent. This result suggests that revealed banks may have continued borrowing from the RFC because their identities were already revealed, and they did not need to worry about

"additional" stigma. Furthermore, as deposit withdrawals followed after the publication of the list, they likely needed more funds (Anbil, 2017).

Table 5: Probability of Approaching the RFC after Bank Identity is Revealed on List

	(1) OLS	(2) Probit
main		
Revealed Bank	0.518***	1.488***
	(6.98)	(5.02)
Controls	Yes	Yes
Observations	230	230
R^2	0.3316	

This table presents the results of OLS and probit cross-sectional regressions on the probability of approaching the RFC after a bank's identity was revealed to the public on or after August 22. Controls is a vector of bank-level, state-level, and county-level controls. Bank-level controls include the average log of total assets. State-level controls include per capita income, total dollar deposits, total dollar deposits at suspended banks, the number of banks, and the number of suspended banks. County-level controls include the total population, the number of manufacturing establishments, the dollar amount of wholesale sales, the dollar amount of retail sales, the amount of crop land, the number of unemployed persons, and the unemployment rate. T-statistics are calculated robustly and presented in parentheses. All continuous variables are winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Next, we compare the performance of switched banks to banks that remained at the DW after the publication of the list. Because these banks valued confidentiality by switching to the DW, we expect their subsequent balance sheet composition to be similar to DW banks. Table 6 presents the results. Switched banks did not contract their lending and only experienced a small drop in their bonds-and-securities portfolio of 4.2 percentage points in comparison with DW banks. This result is possibly by construction because switchers had to pledge collateral to the RFC and then possibly more collateral to the DW. Furthermore, banks that switched to the DW continued making loans to banks at the same rate as DW banks (the coefficient $SwitchedBank_i \times 1\{t \geq List\}$ is insignificant). These results provide evidence for *Hypothesis 4* that switched and DW banks would have similar balance sheet trends after the publication of the list because both groups of banks wanted to avoid stigma

and were less concerned with rollover risk. Furthermore, these findings align with the joint model in that switched and DW banks are not statistically different from one another.

Table 6: Performance of Switched Banks relative to DW Banks

	(1) bonds	(2) loans	(3) cash
$SwitchedBank_i \times 1\{t = List - 1\}$	-0.008	-0.022	0.007
	(-0.46)	(-0.93)	(0.61)
$SwitchedBank_i \times 1\{t \geq List\}$	-0.042**	-0.052	-0.018
	(-2.29)	(-1.58)	(-1.29)
Time FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
$Controls_i \times 1\{t \geq List\}$	Yes	Yes	Yes
Observations	822	832	832
R^2	0.8265	0.6852	0.6374

This table presents the reduced form estimates of the effect of the list published on August 22, 1932 on bonds, loans, and cash. Switched Bank is a dummy that equals 1 if the bank borrowed from the RFC prior to August 22, and then borrowed from the DW or not at all afterwards. $SwitchedBank_i \times 1\{t \geq List\}$ equals 1 if the bank switched to the DW on or after August 22. $SwitchedBank_i \times 1\{t = List - 1\}$ equals 1 if the bank switched to the DW before the first list was published. $Controls_i \times 1\{t \geq List\}$ is a vector of bank-level, state-level, and county-level controls that turn on when $1\{t \geq List\}$ equals 1, and are measured as of December 31, 1930. Bank-level controls include the log of total assets. State-level controls include per capita income, total dollar deposits, total dollar deposits at suspended banks, the number of banks, and the number of suspended banks. County-level controls include the total population, the number of manufacturing establishments, the dollar amount of wholesale sales, the dollar amount of retail sales, the amount of crop land, the number of unemployed persons, and the unemployment rate. Bonds equals a bank's bonds and securities portfolio divided by lagged assets. Loans equals a bank's loans and discounts portfolio divided by lagged assets. Cash equals a bank's cash due from banks divided by lagged assets. T-statistics are clustered at the bank level and presented in parentheses. All continuous variables are winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Next, we compare the performance of revealed banks to DW banks after the publication of the list. Table 7 presents the results. Revealed banks experienced large drops of 9.8 and 15.3 percentage points drop in their bonds-and-securities and loans-and-discounts portfolios, respectively, in comparison with DW banks. Revealed banks were forced to considerably contract their lending and write down assets on their balance sheet. These results confirm

Hypothesis 2 where we expected the performance of revealed banks to be the worst among all the groups. In addition, while these findings align with the joint model, this approach adds to our understanding by allowing us to examine statistical differences between these groups before the list was published. We find that these groups of banks were not statistically different with respect to bonds, loans, and cash (the coefficient on $RevealedBank_i \times 1\{t = List - 1\}$ is insignificant). Were it not for the publication of the list, it is likely that the bond, loan, and cash trends for revealed banks in comparison with DW banks would have been parallel.

Table 7: Performance of Revealed Banks relative to DW Banks

	(1) bonds	(2) loans	(3) cash
$RevealedBank_i \times 1\{t = List - 1\}$	-0.026	-0.060	-0.001
	(-0.80)	(-1.58)	(-0.05)
$RevealedBank_i \times 1\{t \geq List\}$	-0.098***	-0.153***	-0.024
	(-2.94)	(-3.04)	(-1.37)
Time FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
$Controls_i \times 1\{t \geq List\}$	Yes	Yes	Yes
Observations	728	734	734
R^2	0.8391	0.6568	0.6263

This table presents the reduced form estimates of the effect of the list published on August 22, 1932 on bonds, loans, and cash. $Revealed_i \times 1\{t \geq List\}$ equals 1 if the bank was published on a list on or after August 22. $Revealed_i \times 1\{t = List - 1\}$ equals 1 for revealed banks prior to the publication of the list. $Controls_i \times 1\{t \geq List\}$ is a vector of bank-level, state-level, and county-level controls that turn on when $1\{t \geq List\}$ equals 1, and are measured as of December 31, 1930. Bank-level controls include the log of total assets. State-level controls include per capita income, total dollar deposits, total dollar deposits at suspended banks, the number of banks, and the number of suspended banks. County-level controls include the total population, the number of manufacturing establishments, the dollar amount of wholesale sales, the dollar amount of retail sales, the amount of crop land, the number of unemployed persons, and the unemployment rate. Bonds equals a bank's bonds and securities portfolio divided by lagged assets. Loans equals a bank's loans and discounts portfolio divided by lagged assets. Cash equals a bank's cash due from banks divided by lagged assets. T-statistics are clustered at the bank level and are presented in parentheses. All continuous variables are winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Although the revelation was costly to these banks, revealed banks were far more likely to approach the RFC suggesting they were desperate for funds.[16] Overall, these results imply that the RFC attracted more desperate banks after the publication of the list. These banks were more concerned with rollover risk due to their shrinking bond-and-securities portfolios, and preferred the longer-duration loans of the RFC over their fear of stigma. Prior to the publication of the list, market participants would have been unable to separate each bank's distinct preferences because all banks pooled together at both facilities.

Finally, we compare the performance of RFC banks to DW banks after the publication of the list. Table 8 presents the results. RFC banks experienced drops of 5.2 and 5.8 percentage points in their bonds-and-securities and loans-and-discounts portfolios (albeit at the 10% level), respectively, in comparison with DW banks. Like Table 7, the coefficient on $RFC_i \times 1\{t = List - 1\}$ is insignificant suggesting that were it not for the publication of the list, RFC and DW banks would have had parallel bond, loan, and cash trends.

RFC banks also contracted their lending and wrote down their assets, but less so than revealed banks, confirming *Hypothesis 3* where we expected the performance of RFC banks to be slightly better than revealed banks. Since RFC bank identities were not revealed to the public, this is likely driving the smaller drops in their loan and bond portfolios. However, these banks were willing to approach the RFC despite the chance their identities would be revealed on a subsequent list. This behavior suggests that RFC banks were also desperate for RFC funds, and they preferred lower rollover risk over the cost of being revealed to the public. Furthermore, interestingly, RFC banks experienced no drop in their cash-due-to-banks portfolios. This might suggest that RFC banks continued to support their correspondent network, although qualitatively less than DW banks.

The results in this section align with the findings in the joint model in that many of these subgroups of banks have statistically different balance sheets after the publication. A key finding in this section is that prior to the publication, the trends of bonds-and-securities,

[16] We do not observe which banks were rejected from the DW. However, from our trivariate model, we find that borrowing from the DW in 1931 increased the probability that a bank received RFC assistance by 14.6 percentage points.

Table 8: Performance of RFC Banks relative to DW Banks

	(1) bonds	(2) loans	(3) cash
$RFCBank_i \times 1\{t = List - 1\}$	-0.023	-0.036	0.001
	(-1.22)	(-1.33)	(0.13)
$RFCBank_i \times 1\{t \geq List\}$	-0.052***	-0.055*	-0.016
	(-2.92)	(-1.83)	(-1.32)
Time FE	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes
$Controls_i \times 1\{t \geq List\}$	Yes	Yes	Yes
Observations	937	947	947
R^2	0.8453	0.6714	0.6287

This table presents the reduced form estimates of the effect of the list published on August 22, 1932 on bonds, loans, and cash. $RFCBank_i \times 1\{t \geq List\}$ equals 1 if the bank borrowed from the RFC after the first list was published on August 22, 1932. $RFCBank_i \times 1\{t = List - 1\}$ equals 1 for RFC banks prior to the publication of the list. $Controls_i \times 1\{t \geq List\}$ is a vector of bank-level, state-level, and county-level controls that turn on when $1\{t \geq List\}$ equals 1, and are measured as of December 31, 1930. Bank-level controls include the log of total assets. State-level controls include per capita income, total dollar deposits, total dollar deposits at suspended banks, the number of banks, and the number of suspended banks. County-level controls include the total population, the number of manufacturing establishments, the dollar amount of wholesale sales, the dollar amount of retail sales, the amount of crop land, the number of unemployed persons, and the unemployment rate. Bonds equals a bank's bonds and securities portfolio divided by lagged assets. Loans equals a bank's loans and discounts portfolio divided by lagged assets. Cash equals a bank's cash due from banks divided by lagged assets. T-statistics are clustered at the bank level and presented in parentheses. All continuous variables are winsorized at the 1% level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

loans-and-discounts, and cash-due-to-banks across revealed, RFC, switched, and DW banks were not statistically different. This finding also corroborates the summary statistics in Table 1 where no drastic differences in balance sheet composition were found across the subgroups. These parallel trends help alleviate some selection bias when we interpret the results of our panel data approach.

6 Implications for LOLR Facilities

In this paper, we use an unexpected information revelation that leaked confidential bank loans authorized by the RFC to examine how banks changed their choice of emergency lending facility. The revelation shocked banks' choice of facility, allowing us to examine how their choice of facility was related to risk preferences. We find that the pool of RFC and DW borrowers ex-post separated into specific subgroups of banks that revealed information about their liquidity condition to market participants. Prior to the information revelation, this information would have been unavailable to policymakers because banks were pooling by borrowing from both facilities.

We find that banks that borrowed from the RFC after the revelation were of worse liquidity condition, and correspondingly further wrote down assets on their balance sheet and contracted their lending. In contrast, banks that switched away from the RFC were able to maintain their lending and their liquidity buffer of safe assets. Our results shed light on how lending facilities can be designed that achieve three objectives: (1) ease funding constraints; (2) are least subject to a stigma problem; and (3) attract banks that are less likely to use emergency assistance for excessive risk-taking.

Altogether, our results imply that the presence of two lending facilities, where one guarantees anonymity while the other does not, might separate banks in a way that reveals their liquidity condition to market participants. Because a crucial concern when designing a lending facility is to attract banks that are less likely to use assistance for excessive risk-taking, our results suggest that the presence of a facility that guarantees anonymity will reduce moral hazard concerns only when another stigmatized facility is present. Our results provide clarity about the recent crisis where two emergency lending facilities were available to banks, where one was considered stigmatized (DW) and the other stigma-free (TAF). At the time, "solvent but illiquid" banks were considered more likely to approach the TAF. Since DW loans were considered to be leaked, banks' choice to approach the TAF may have revealed a lesser desperation for emergency assistance to policymakers. Our paper sheds light on the performance and preferences of banks when multiple lending facilities are present.

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