LIQUIDITY FROM TWO LENDING FACILITIES

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November 16, 2017

Abstract

During financial crises, lending facilities are available to assist banks and inject liquidity into the banking sector. We examine a scenario where there are two facilities and an information revelation occurs which stigmatizes one facility. We exploit this unexpected difference between the facilities and develop a model of banks’ endogenous facility choice to evaluate whether the assistance is used to improve funding needs. We find that the information revelation forces the pool of borrowers to separate into subgroups that reveal their liquidity conditions. We shed light on how to design lending facilities that attract banks with liquidity, not risk, incentives.

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1 Introduction

During the recent financial crisis, the Federal Reserve acted as the lender of last resort (LOLR) to inject critical liquidity into 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. However, banks were reluctant to borrow from the Federal Reserve’s DW because if they somehow became known, market participants may 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 could experience deposit withdrawals and their lending could contract (Anbil, 2017; Vossmeyer, 2017).

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 the access to emergency assistance (Mishkin and Serletis, 2013). In this scenario, LOLR lending facilities may increase overall systemic risk in the financial system, rather than ease funding constraints. Thus, an important challenge for an LOLR is identifying the solvent yet illiquid banks in need of assistance and those that will use the funds appropriately.

In this paper, we examine why banks borrow from the LOLR and how the support is used. We 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 with funding concerns. A large methodological challenge in addressing this topic is disentangling a bank’s funding needs, its endogenous choice to approach the LOLR, and its subsequent performance. To overcome this difficulty, we use an unexpected event and information revelation from the Great Depression that offers variation in why and when banks approach their LOLR.

The Great Depression was the worst financial crisis in U.S. history during which LOLR lending was considerable (Bernanke, 1983). Two lending facilities were available to provide
loans confidentially to banks – the Reconstruction Finance Corporation (RFC) and the Federal Reserve’s Discount Window (DW). When the RFC was established, it operated similarly to the DW and many banks could approach either facility or both. However, an unexpected information revelation occurred that revealed the identities of banks that had secretly borrowed from the RFC to market participants, which introduced a stigma problem at the RFC (Anbil, 2017; Vossmeier, 2017). We exploit this sudden difference between the two facilities to better understand bank choice of facility.

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 1933, 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 and system of equations are necessary because banks are nonrandomly selecting which facility to approach and when, which endogenously affects their liquidity and balance sheet preferences. Additionally, we employ a panel data approach to incorporate more time dynamics and further investigate our topic of interest.

We find that the pool of banks that approach lending facilities ex-post separate into specific subgroups that differ on observable dimensions after the information revelation. In particular, subsets of banks remain at the stigmatized facility (RFC), switch away from the stigmatized facility, or avoid the facility completely. This separation of borrowers reveals information about their liquidity condition to market participants. Prior to the revelation, this information was unavailable since all LOLR borrowers were pooled together. Next, we study how the information revelation affected the balance sheet composition of banks based on their choice of facility. We find that post-separation, banks that remained at the stigmatized facility later decreased their position of safe assets, decreased their lending to the real economy, and wrote down their assets, in comparison with banks that avoided or switched away from the stigmatized facility. 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.
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 informative 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 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 banks not focused on liquidity concerns.

During the recent financial crisis, two lending facilities existed where one facility was considered to be stigmatized (much like the Great Depression). The Term Auction Facility (TAF) was an emergency lending facility that was considered to not have a stigma problem because bank participation was considerable (Armantier et al., 2015). On the other hand, DW borrowing remained low because of a potential stigma problem. Our results shed light on how policymakers can use the existence of two facilities to order banks based on their liquidity preferences.

Our paper contributes to several literatures, one of which is a growing macroeconomic theory literature on how adverse selection affects markets. Bajaj (2017) studies the transition of a no-information revelation regime (pooling equilibrium) to information revelation regime (separating equilibrium). She shows that a negative shock to the quality of the regime implies a switch from no-information revelation regime to an information revelation regime. Our paper presents a no-information revelation regime where banks choose to borrow from two facilities. Market participants cannot determine information about the quality of banks that approach either facility because they pool together. However, the unexpected disclosure of bank names caused a negative shock to the design of the RFC, which led banks to separate

\[1\] 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.
into distinct groups that ex-post revealed information about their liquidity preferences to
market participants. To the best of our knowledge, our paper is one of the first to provide
empirical evidence of these macroeconomic theories.

Our paper also relates to the finance literature on why banks approach their LOLR, which
is limited because researchers face major challenges in identification. Drechsler et al. (2016)
show that weakly capitalized banks took out more LOLR loans and used riskier collateral
than strongly capitalized banks. We are able to shed light on the lending facility that would
attract more strongly capitalized banks during a financial crisis. Our results align with their’s
in that we find weaker banks borrowed to buy less-safe assets. Carpinelli and Crosignani
(2017) find that banks that experienced a wholesale funding dry-up before the European
Central Bank’s (ECB) long term refinancing operation (LTRO) used their funding to restore
credit supply, while banks that did not receive as much funding used it to increase their
holdings of high-yield government bonds. We shed light on the type of lending facility where
a bank “reaching for yield” may not occur. Finally, Acharya et al. (2016) find that the ECB
temporarily reduced funding pressure for banks but did not address solvency concerns via
LTROs, suggesting it was difficult for the ECB to separate solvent but illiquid banks from
those prone to risk-taking.

Finally, our paper is related to the literature of how banks use their LOLR loans. Benm-
elech et al. (2017) find that had LOLR interventions been effective in preventing the collapse
of the asset-backed commercial paper market, then the interventions might have contained
the real effects of the crisis. We find that banks at the non-stigmatized facility (DW) did
not contract their lending, which can be interpreted as a success of the DW. 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. However, Alves
et al. (2016) find that when Portuguese banks were prevented from going to repo markets
during the European sovereign debt crisis, it was the virtually unlimited access to central
bank funding that helped banks continue to provide funding to the real economy. Our paper
suggests that an anonymous lending facility (with no stigma problem) may attract banks
that will maintain their lending and that are more concerned with the liquidity of their balance sheet.

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, the development of our trivariate model, and our linear panel model. Section 4 presents the results of the trivariate model and our panel approach. Finally, Section 5 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.\(^2\)

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).\(^3\) 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

\(^2\)Of the total amount of bank loans requested from the RFC, 80 percent were granted.

\(^3\)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.
from the RFC by June 30, 1933.

Upon the RFC’s establishment, the RFC and DW operated very 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. 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 1932.4 These facts highlight the significance of the RFC and DW, their effect on the financial system, and their functions as lenders.

The key element here is that member banks in need of a loan had the option of approaching the RFC, the DW, or both. It is important to note, however, that the framework in this paper does not require any sort of proportional substitutability between the facilities. Thus,

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4The 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).
independence of irrelevant alternatives is not an assumption imposed on banks here and we are not requiring that the facilities be interchangeable. The framework is flexible and allows for the choices to be correlated but there are no restrictions on that structure.

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 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 (2001b,a, 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

The main event in this paper is the information revelation that exposed banks that confidentially borrowed from the RFC – the introduction of stigma at the RFC. While there are several differences between the facilities listed above, the stigma difference was unexpected by banks and shocked their 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). 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 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.

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5 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).
2.3 Timeline

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 Federal Reserve member banks in the 6th 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 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.

Based on the sudden stigma, we are interested in how the pool of LOLR borrowers separated into specific subgroups: 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 believe that this endogenous choice is revealing of bank condition. 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).

In order to capture the population of member banks at this time, 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; Vossmeier, 2017).

Figure 2 shows that there were 325 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

\(^6\)Our paper is limited to studying banks in the Federal Reserve Sixth District because DW data is only available from this District. In addition, we only study banks that were eligible to approach both the DW and RFC.
This figure provides a flow chart of a bank’s choice of LOLR on or after February 2, 1932. After the information revelation on August 22, we are interested in banks that continued borrowing from the RFC (“RFC banks”), banks that switched away from the RFC “switched banks”, and banks that continued borrowing from the DW (“DW banks”).

*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.

With this setting, we find ourselves asking a series of questions and developing several hypotheses. First, why would a bank want to 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 (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 the choice framework and jointly model the
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.

unobservables relating RFC choice and DW choice.

Why would a bank want to 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 bank choice reveals their liquidity condition to market participants. These funding demands are difficult, if not impossible, to
disentangle in a setting where there is a single lending facility.

We expect non-applicant banks to be the highest-capitalized banks in the Sixth District because the Federal Reserve Bank of Atlanta 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.

Because stigma was costly and present at the RFC (Anbil, 2017; Vossmeyer, 2017), we expect the performance of revealed and RFC banks to be the worst among these groups of banks. Revealed banks faced deposit withdrawals likely forcing them to sell their most liquid securities to meet depositor demand. Therefore, we expect these banks to be the most desperate for liquid securities and emergency assistance, and their performance to be the most unlike non-applicant banks. On the other hand, due to the nature of the list publications, not all RFC banks were revealed to the public to have received loans. Those banks with loans authorized prior to July 21, 1932 with loans less than $100,000 remained confidential. However, 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 with many not facing immediate deposit withdrawals. As a result, we expect the performance of RFC banks to be better than revealed banks.

Finally, we expect the performance of banks that switched or remained at the DW to be the most like non-applicant banks. These banks were unwilling to bear the cost of stigma and valued loan confidentiality over borrowing from the RFC. Because they valued confidentiality more, they would not experience immediate deposit withdrawals due to the publication.

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7We 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.
3 Data and Methodology

3.1 Data

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. 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.

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 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, bank age for each bank. The data are hand-collected from

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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.
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 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 theory 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.

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. On the other hand, 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

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

This table provides summary statistics for RFC, DW, switched, and revealed 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.

### 3.3 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 employs a cross-sectional sample, which includes all National banks operating in the Sixth Federal Reserve District. These are 270 banks that faced an LOLR choice: borrow from both the DW and RFC, borrow from the DW, borrow from the RFC, or do not borrow. The analysis jointly models this choice set along with bank performance to accommodate concerns of sample selection and endogeneity. In our reduced form approach, the main source of identification is the unexpected publication of banks that confidentially borrowed from the RFC beginning on August 22, 1932. We analyze the performance of eligible banks in the Federal Reserve Sixth District after the publication of the list in a panel data set from December
Table 2: Loan Amount Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>RFC</th>
<th>DW</th>
<th>Switched</th>
<th>Revealed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Averages in millions before August 22, 1932</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFC loan amount</td>
<td>20.9</td>
<td>0</td>
<td>102.3</td>
<td>145.4</td>
</tr>
<tr>
<td>DW loan amount</td>
<td>118.1</td>
<td>69.9</td>
<td>118.9</td>
<td>208.4</td>
</tr>
<tr>
<td><strong>Averages in millions after August 22, 1932</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFC loan amount</td>
<td>101</td>
<td>0</td>
<td>0</td>
<td>193.2</td>
</tr>
<tr>
<td>DW loan amount</td>
<td>109.3</td>
<td>128.3</td>
<td>244.1</td>
<td>126.7</td>
</tr>
</tbody>
</table>

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.

31, 1930 to September 30, 1934, where these panel data do not include banks that did not borrow (non-applicant banks). The panel analysis captures better time dynamics.

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. To the best of our knowledge, we are the first to analyze the effectiveness of the DW during the Great Depression using micro-loan data. In addition, we can cleanly identify whether liquidity-seeking behavior after receiving an LOLR loan should be an important consideration when designing future LOLR lending facilities.

### 3.3.1 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.

Taking all of these points together, to properly model a bank’s choice and performance, we employ a novel trivariate model with recursive endogeneity and estimation algorithm. The framework jointly examines the determinants of a bank’s endogenous LOLR choice and its subsequent liquidity 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 key 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:

\[
\begin{align*}
  z_{i1} &= x'_{i1}\beta_1 + \varepsilon_{i1} \\
  z_{i2} &= x'_{i2}\beta_{21} + x'_{i2, endog}\beta_{22} + \varepsilon_{i2} \\
  z_{i3} &= x'_{i3}\beta_{31} + x'_{i3, endog}\beta_{32} + \varepsilon_{i3}
\end{align*}
\]

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

\[
\Omega = \begin{pmatrix}
  1 & \omega_{12} & \omega_{13} \\
  \omega_{21} & 1 & \omega_{23} \\
  \omega_{31} & \omega_{32} & \omega_{33}
\end{pmatrix}.
\]

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

\[
y_{ij} = \begin{cases} 
  1 & \text{if } z_{ij} > 0 \\
  0 & \text{if } z_{ij} \leq 0
\end{cases}
\]

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

\(^{10}\)This differs from a multinomial setting where only one choice is made and proportional substitution is required.
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:

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

Note that the model here has both discrete and continuous outcome variables. Other discrete-continuous models have been used in electricity and transportation research (see, for instance, Dubin and McFadden (1984) and Brownstone and Fang (2014)).

The covariates that enter $x_{i1}$ include the bank’s balance sheet information (loans-and-discounts divided by total assets, deposits divided total liabilities, and other securities divided by total assets) as of December 31, 1931 and its number of principal correspondents. In Equation (2), the covariates that enter $x_{i2}$ 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 liquidity is the ratio of U.S. government securities divided by total assets.\(^{11}\) The covariates that enter $x_{i3}$ 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 $x_{i3, endog}$ is a set of indicator variables defined by $y_{i1}$ and $y_{i2}$, and represent the mutually exclusive 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

\(^{11}\) Our results are robust to using cash-due-to-banks divided by total assets as an additional liquidity measure.
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. 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, estimation relies on simulation-based techniques. However, estimation is further complicated because of the normalizations in the variance-covariance matrix $\Omega$, which are standard in any binary or ordered data setting (Jeliazkov et al., 2008). To overcome these challenges, the paper implements a Bayesian framework for equations (1) through (5). The model is completed by specifying prior distributions for the parameters. It is assumed that $\beta$ has a joint normal distribution with mean $b_0$ and variance $B_0$ and (independently) $\omega \sim N(\rho_0, R_0)1\{\omega \in S\}$, where $S$ is the set of parameters that produce the positive definite matrix $\Omega$. The complete-data posterior is given by:

$$
\pi(\beta, \Omega, z|y) \propto \left( \prod_{i=1}^{n} \prod_{j=1}^{2} 1\{z_{ij} > 0\} N(z_{i}|X_i\beta, \Omega) \right) \times N(\beta|b_0, B_0)N(\omega|\rho_0, R_0)1\{\omega \in S\}.
$$

The above posterior gives rise to a Markov chain Monte Carlo (MCMC) estimation algorithm. The novel 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 \( z \), 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 “\( \setminus k \)” to represent all elements in a set except the \( k \)th one. Details on the sampler are as follows:

**Algorithm 1 MCMC Estimation Algorithm**

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

\[
\hat{\beta} = \hat{B} \left( B_0^{-1} b_0 + \sum_{i=1}^{n} X_i' \Omega^{-1} z_i \right) \quad \text{and} \quad \hat{B} = \left( B_0^{-1} + \sum_{i=1}^{n} X_i' \Omega^{-1} X_i \right)^{-1}.
\]

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

3. **For equations** \( k = 1, 2 \), sample \( z_{ik}|y, \beta, \Omega, z_{\setminus k} \sim T N_{A_i}(\mu_{k|\setminus k}, V_{k|\setminus k}) \) where \( \mu_{k|\setminus k} \) and \( V_{k|\setminus k} \) are the usual conditional mean and conditional variance, respectively. If \( y_{ik} = 0 \), \( A_i \) is \((-\infty, 0)\), and if \( y_{ik} = 1 \), \( A_i \) is \((0, \infty)\).

We use only the 270 National banks in Alabama, Florida, Georgia, and Tennessee operating in the Sixth District in 1931 as our sample for our trivariate model, including the 85 non-applicant banks where we control for any sample selection bias when comparing banks that borrowed from a LOLR to banks that did not. In our reduced form approach, we include both National and State member banks but we do not include non-applicant banks. We only include National banks in the trivariate model because of data limitations. From the OCC’s Individual Statements of Condition of National Banks, we are provided much more detailed balance sheet categories that include U.S. government securities, but these data 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 because of these better balance sheet data, so these limitations are understood in the literature.
3.3.2 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. The approach here allows us to capture more time dynamics, making better use of the panel structure of the data. In addition, the platform serves as a way to address the robustness of the trivariate results in a simple framework.

We run the following bank-level ordinary least squares regression (OLS) from December 31, 1930 through September 30, 1934:

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

where \( Y_{i,t} \) 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 \( \beta_1 \), which measures the change in \( Y_i \) following the publication of the list for RFC banks in comparison with DW banks.\(^{12}\)

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, \(^{12}\)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.
$X_i \times 1\{t \geq \text{List}\}$ to mitigate this bias where the controls only enter into the specification 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 $1\{t \geq \text{List}\}$ equals 1.

However, the specification may still be biased if some bank characteristics are unobservable. Therefore, we rely on bank fixed effects, $\delta_i$ 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, $\eta_t$ 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.

4 Results

4.1 Trivariate Choice-Performance Model

Table 3 displays the results for the trivariate model with recursive endogeneity. 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 preferences, respectively.\footnote{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.}

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

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

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 $x_{i;2,\text{endog}}$ in Equation (2). Endog: RFC Bank, Endog: Non-Applicant, Endog: Switched, and Endog: Revealed are the estimates for the endogenous covariates in Equation (3).

The probability of receiving RFC assistance between cases when banks did and did not receive DW assistance in 1931. The two vectors $X_i^{\dagger}$ and $X_i^{\ddagger}$ differ only in the value of $X_{i,\text{DW Pre-RFC}}$.
and $\theta$ 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:

$$
\delta_{DW, Pre-RFC} = \int \left[ \Pr \left( y_i = 1 | X_{i}^T, \theta \right) - \Pr \left( y_i = 1 | X_{i}^T, \theta \right) \right] f \left( X \right) \pi \left( \theta | y \right) dX d\theta. \quad (8)
$$

The covariate effect is 0.146 and a histogram of the probability distribution is displayed in Figure 3. 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 the banks’ random utility function as they maximize.\textsuperscript{14}

Figure 3: Covariate effect of DW assistance on RFC assistance.

![Histogram of covariate effect](image)

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 bank liquidity preferences 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.

\textsuperscript{14}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, inconsistent with liquidity-seeking behavior. Because the information revelation forced banks that were pooling together at the DW or RFC to separate, RFC and revealed banks exposed their 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. This information would have been impossible to determine without the sudden difference in the facilities or with only a single facility.

Table 4 presents the posterior means, standard deviations, and implied correlation form for Ω which sheds light on how well observable variables can predict a bank’s choice of LOLR. \( \omega_{12} \) 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 is positive and statistically different from 0, thus the join model is necessary. Variables controlled for in the equations that include 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 \( \omega_{13} \) and \( \omega_{23} \). They represent the covariance between the errors of seeking DW assistance and holding U.S. government securities and 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 $\Omega$ in the Trivariate Model.

<table>
<thead>
<tr>
<th>$\Omega$</th>
<th>$\omega_{11}$</th>
<th>$\omega_{12}$</th>
<th>$\omega_{22}$</th>
<th>$\omega_{13}$</th>
<th>$\omega_{23}$</th>
<th>$\omega_{33}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1</td>
<td>0.159</td>
<td>1</td>
<td>0.031</td>
<td>0.033</td>
<td>0.021</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.</td>
<td>0.236</td>
<td>.</td>
<td>0.011</td>
<td>0.010</td>
<td>0.004</td>
</tr>
<tr>
<td>Implied Correlation</td>
<td>1</td>
<td>0.159</td>
<td>1</td>
<td>0.214</td>
<td>0.228</td>
<td>1</td>
</tr>
</tbody>
</table>

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

4.2 Reduced Form Approach

We use a linear panel data model to further examine the response of banks to the publication of the list on August 22, 1932. The approach here offers a more simple interpretation and makes better use of time dynamics in the panel setting. We analyze the 4 subgroups of LOLR borrowers based on their balance sheet composition.

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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>Probit</td>
</tr>
<tr>
<td>Revealed Bank</td>
<td>0.518***</td>
<td>1.488***</td>
</tr>
<tr>
<td></td>
<td>(6.98)</td>
<td>(5.02)</td>
</tr>
<tr>
<td>Controls</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>230</td>
<td>230</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.3316</td>
<td></td>
</tr>
</tbody>
</table>

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 4.1 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 confirm our earlier conjecture 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 trivariate
model in which switched and DW banks are not statistically different from one another.

Table 6: Performance of Switched Banks relative to DW Banks

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

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. $SwitchedBank_i \times 1\{t = List - 1\}$ 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. While these findings align with the trivariate model, the approach here adds to our understanding by allowing us to examine statistical differences between these groups before the list was published. Here, we find that these groups were not statistically different before the publication, and only after do they diverge on many balance sheet characteristics.

Table 7: Performance of Revealed Banks relative to DW Banks

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

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, they were far more likely to approach
the RFC suggesting they were desperate for funds. Overall, these results imply that the RFC attracted more desperate banks after the publication of the list. It is also likely that 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 determine these distinct liquidity preferences from switched or DW banks. The publication forced banks to separate into groups that ex-post revealed their liquidity condition.

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. Additionally, before the publication, these banks were not statistically different, as shown by the List – 1 results.

RFC banks were also forced to contract their lending and write down their assets but at a rate less than revealed banks. Since many 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 trivariate model in that many of these subgroups of banks have statistically different balance sheets after the publication. A key contribution in this section is that we find that prior to the publication, these subgroups are not statistically different. This finding corroborates the description in the raw data from Table 1, where it appears there are not drastic differences in the subgroups of banks prior to

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15 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

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bonds</td>
<td>loans</td>
<td>cash</td>
</tr>
<tr>
<td>( \text{RFCBank}_i \times 1 { t = \text{List} - 1 } )</td>
<td>-0.023</td>
<td>-0.036</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(-1.22)</td>
<td>(-1.33)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>( \text{RFCBank}_i \times 1 { t \geq \text{List} } )</td>
<td>-0.052***</td>
<td>-0.055*</td>
<td>-0.016</td>
</tr>
<tr>
<td></td>
<td>(-2.92)</td>
<td>(-1.83)</td>
<td>(-1.32)</td>
</tr>
<tr>
<td>Time FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bank FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>( \text{Controls}_i \times 1 { t \geq \text{List} } )</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>937</td>
<td>947</td>
<td>947</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.8453</td>
<td>0.6714</td>
<td>0.6287</td>
</tr>
</tbody>
</table>

This table presents the reduced form estimates of the effect of the list published on August 22, 1932 on bonds, loans, and cash. \( \text{RFCBank}_i \times 1 \{ t \geq \text{List} \} \) equals 1 if the bank borrowed from the RFC after the first list was published on August 22, 1932. \( \text{RFCBank}_i \times 1 \{ t = \text{List} - 1 \} \) equals 1 for RFC banks prior to the publication of the list. \( \text{Controls}_i \times 1 \{ t \geq \text{List} \} \) is a vector of bank-level, state-level, and county-level controls that turn on when \( 1 \{ t \geq \text{List} \} \) 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.

5 Implications for LOLR Facilities

In this paper, we examine which banks borrow from LOLRs and when they do so. We 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 with liquidity.
We use a unique setting of an unexpected information revelation that introduced stigma at one of two lending facilities during the Great Depression: the RFC and the DW. Using a unique hand-collected data set of balance sheet, DW, and RFC loan information for banks in the Federal Reserve Sixth District, we implement a trivariate model with recursive endogeneity to model banks’ endogenous choice of facility and its subsequent liquidity preferences, as well as a linear panel data model to capture additional time dynamics. We find that the pool of LOLR borrowers ex-post separated into specific subgroups of banks that revealed information about their liquidity preferences 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. After the separation, banks that avoided or switched away from the stigmatized facility continued their lending to the real economy and maintained their liquid assets, which is not the case for banks at the stigmatized facility. This divergence would be impossible to observe in the presence of only one facility. Altogether, our results imply that a facility that guarantees anonymity might attract banks that value a more liquid balance sheet only when another facility with a stigma problem is present.

Because a crucial concern when designing a lending facility is to reduce stigma and attract banks that are illiquid rather than risky, it seems that designing a facility that guarantees anonymity will reduce moral hazard concerns only when another facility with a stigma problem is present. Then, the anonymous facility would attract banks that would likely continue lending to the real economy and reduce the ex-ante concern of lending to riskier banks. It is not unusual to have a setting with two facilities where one is stigmatized, as this was a feature of the recent crisis with the TAF (not stigmatized) and DW (stigmatized). Our paper sheds light on the performance and preferences of banks when multiple lending facilities are present.
References


