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Bank partnership and liquidity crisis ☆

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ABSTRACT

This study empirically investigates the relationship between banking integration and liquidity management. To measure banks' connectivity, we use the number of partnerships proxied via the syndicated loan arrangements in which they serve as lead arrangers. If banks establish more business partnerships through syndicated loan arrangements, those under market stress are more likely to face increased funding costs, create reduced liquidity, and originate declined small business loans and mortgages. Those banks with more partners are shown to have a lower liquidity coverage ratio, suggesting that business partnerships create a disincentive toward liquidity risk management.

1. Introduction

Amid the 2007–2009 financial crisis (hereafter, the "financial crisis"), many banks experienced severe funding issues due to liquidity evaporation and interbank market freezes, and it is necessary to understand why. Academicians and policymakers view interbank connections in integrated financial markets as one of the key drivers behind the liquidity constraints seen during the financial crisis. Castiglionesi, Feriozzi, and Lorenzoni (2019) develop a theoretical model in which financial integration leads to a reduction of total liquid resources in the banking system, making it more vulnerable to systemic shock. Despite the significant implications of the relationship between interbank connections and the liquidity problems of banks, empirical research is limited. In this study, we fill the gap by employing interbank business partnerships formed through syndicated loan arrangements as the key measure for interbank relationships and empirically investigate how a bank's growing relationships with its business partners affect its vulnerability to liquidity shocks under market stress.

Banks' reliance on interbank funding could be highly correlated with their liquidity risk management. On the one hand, as banks' accessibility to interbank borrowing grows, the banks' motivation to strengthen their liquidity risk management could be weakened. On the other hand, if banks face higher liquidity risks, they may be more strongly incentivized to engage in interbank borrowing as an alternative to their liquidity risk control. In other words, there could be simultaneous causality between banks' reliance on interbank funding and their liquidity risk management. For this reason, we employ a new measure that effectively captures the interbank connection but is less influenced by the banks' liquidity risks—the number of a bank's business partnerships with financial institutions constructed by its syndicated loan arrangements. We find a strong positive correlation between our new measure for interbank business partnerships and the interbank market activity variable in the existing literature (e.g., Castiglionesi, Feriozzi, Lóránth, and Pelizzon, 2014).

Banks' business partnerships made through syndicated loan arrangements have grown dramatically since the early 1990s (Berlin, Nini, and Yu, forthcoming; Jiang, Li, and Shao, 2010). Fig. 1 highlights the rapid growth in the number of business partnerships between lead arrangers and their participating financial institutions established by syndicated loan arrangements from the mid-1990s to the financial crisis. A bank's growing business partnerships with

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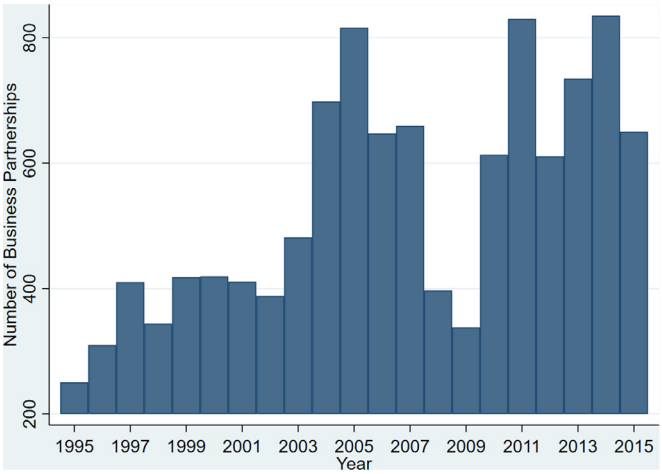

Fig. 1. Trend of the number of banks' business partnerships.
This figure presents the trends for the number of business partnerships formed by the syndicated loan arrangements between a lead arranger bank and participating financial institutions. The number of business partnerships is counted as the pairs of a lead arranger bank and individual participating financial institution for each syndicated loan. Each arranger bank's number of business partnerships is aggregated at its BHC level each year. BHCs that have no syndicated loan lead arranger bank are not included in this figure.

other financial institutions may be an important source of its increasing accessibility to interbank funding. We hypothesize that pre-existing syndicated loan business partnerships may mitigate the information asymmetries between the lead arranger bank and its partnered financial institutions, facilitating funding between the lead arranger and participants, given the former's urgent money demand. As noted by Castiglionesi et al. (2019), financial integration among banks encourages banks to reduce their liquidity holdings and shift their portfolios toward less-liquid investments, increasing the bank's vulnerability to liquidity shocks. Against this background, we predict that a bank with more business partnerships through its syndicated loan arrangements has less incentive to strictly manage its liquidity risk, ultimately making it more vulnerable to liquidity constraints during market stress.

In this study, we aggregate the number of business partnerships between the lead arranger bank and individual participating financial institutions formed through the former's syndicated loan arrangements. We consider all syndicated loan deals arranged by the lead arranger bank from the past five years to the previous year and sum the number of business partnerships from those deals. Finally, we aggregate the number of syndicated loan partnerships of each lead arranger bank at its bank holding company (BHC) level. We drop duplicated partnerships that have repeatedly joined multiple syndicated loan deals lead-arranged by the BHC during the past five years. In our tests, we limit samples to local banks that are subsidiaries of U.S. BHCs and examine the relative liquidity constraints among local banks placed in the same county. Similarly to Cortés (2015), we define a local bank as one that collects more than 65% of its deposits from a single county.

In the first set of regressions, we examine whether a bank with more business partnerships with financial institutions is more likely to be financially constrained in a stressed market. The periods of market stress are defined as the months within the sample period that have monthly average spreads of three-month commercial paper (CP) market yields against risk-free rates in the top 20%, similar to the approach of Acharya and Mora (2015). To measure a bank's financing difficulties during market stress, we employ its average monthly deposit interest rate—the rate for a 12-month certificate of deposit (CD), similar to Drechsler, Savov, and Schnabl (2017). The results show that, if banks are affiliated with BHCs that build more business partnerships with participating institutions through syndicated loan arrangements, they pay higher deposit interest rates in a stressed market. These results suggest that banks with more business partnerships with financial institutions are exposed to higher liquidity shocks than are those with less-extensive partnerships. It is important to note that our results are robust to employing time-county and bank-county fixed effects. These fixed effects enable us to absorb county-specific characteristics, such as local credit demand and economic state, as well as macroeconomic conditions, which may be related to banks' funding costs in stressed markets, and focus on the interbank variation among local banks in the same county at a given time. The regressions also add a number of BHC- or bank-level control variables, including banks' size, capital structure, asset quality, and loan composition, to control for bank-specific characteristics. Moreover, our results are robust to the exclusion of the financial crisis as well as the post-crisis period.

The consequence of the adverse liquidity shocks may not be limited to the banks' external financing but subsequently can be spilled over to the banks' ordinary courses of business, including liquidity creation and lending activities (e.g., Acharya and Mora, 2015; Cornett, McNutt, Strahan, and Tehranian, 2011; Diamond and Rajan, 2001; Khwaja and Mian, 2008). Accordingly, we move on to how the number of a bank's business partnerships relates to bank liquidity creation during market stress. Following Berger and Bouwman (2009), we construct bank liquidity-creation measures based on the ease, cost, and time for customers to obtain liquid funds from the bank as well as the ease, cost, and time for banks to dispose of their obligations to meet their liquidity demands. For instance, the higher the bank liquidity creation, the more liquid the funds in the market from the perspective of customers. We hypothesize that banks with more business partnerships are less likely to create liquidity in the market during periods of market stress.

On average, we find that banks with more relationships with business partners tend to downsize their liquidity creation during periods of market stress compared with banks with fewer such relationships. This finding rules out the alternative explanation that banks with more business partnerships face increasing funding costs due to the increased demand for liquidity provisions in stressed markets. We also find that the results are driven mainly by off-balance-sheet liquidity creation, suggesting that banks with more business partnerships issue liquid guarantees, such as acquired net participation and liquid derivatives, rather than illiquid guarantees, such as unused commitments, which are essential instruments for banks to create liquidity. The results are consistent with previous studies that show that off-balance-sheet liquidity creation comprises a significant proportion of banks' liquidity creation.

Next, we test how the number of a bank's business partnerships is associated with its origination of small business lending as well as mortgage originations in stressed markets. Our regression results indicate that banks with extensive business partnerships are less likely to originate small business lending in market downturns than are banks with fewer such partnerships. For mortgage origination, we find that banks with more business partnerships tend to reduce the origination of jumbo mortgages as well as that of retained mortgages compared with non-jumbo or securitized mortgage origination in stressed markets than do banks with fewer such partnerships. Jumbo mortgages and retained mortgages are considered to be the types of lending severely affected by banks' liquidity issues compared with non-jumbo and securitized mortgages, which are relatively easy to liquidate (e.g., Gilje, Loutskina, and Strahan, 2016; Loutskina and Strahan, 2009). This finding suggests that banks with more business partnerships are more affected by aggregate liquidity shocks and, thus, find it more difficult to meet loan demands during market stress.

Overall, banks partnered with more institutions are more adversely influenced by market stress in terms of their liabilities, assets, and off-balance-sheet activities than are banks partnered with fewer institutions. We hypothesize that readily available external financing incentivizes banks with more business partnerships to loosen their liquidity risk controls by reducing reserves of safe liquid assets and expanding less-liquid assets (Castiglionesi et al., 2019). To identify a channel responsible for the higher vulnerability of banks with more partnerships to liquidity shocks, we investigate whether the more-partnered banks tend to loosen their liquidity risks. To measure the liquidity risk management of banks, we employ the liquidity coverage ratio (LCR). LCR was introduced by the Basel Committee on Banking Supervision (BCBS) after the financial crisis as the new international standard for a bank's liquidity risk measurement and control. LCR measures whether the bank holds sufficient amounts of high-quality liquid assets (HQLAs) to survive stressed market conditions for at least one month.[1] LCR admits only HQLAs as the bank's available liquidity and considers both on- and off-balance-sheet items to measure the bank's expected net cash outflows in periods of market stress. Hong, Huang, and Wu (2014) find that the LCR measure is improved in terms of its adequacy to capture a bank's liquidity risk as compared to the traditional proxies, such as a simple ratio of liquid assets over total assets. We relate a bank's estimated LCR to its number of business partnerships with syndicated loan participants. Because each bank's LCR is not publicly available, we use its financial statement to estimate its LCR, similar to Hong et al. Our results suggest that, as a bank has more business partnerships with financial institutions through its syndicated loan arrangements, it tends to maintain a lower LCR, implying that it loosens its liquidity management and, thus, becomes more vulnerable to liquidity risks. We also find that banks with a lower LCR are more likely to face severe liquidity constraints in a stressed market in terms of deposit funding costs. From all the above test results, we conclude that a bank with more business partnerships tends to relax its liquidity management and subsequently faces more-severe liquidity constraints in a stressed market, as revealed by its higher deposit funding cost, less liquidity creation, and less loan origination for small business lending and mortgages.

This study is the first of its kind to provide empirical evidence on the relationship between the number of banks' business partnerships and liquidity crises in stressed markets. Banks may rely on business partnerships for their liquidity demands instead of holding liquid assets of their own. There is a drawback to their reliance on business relationships with other financial institutions, however, which is exposed in a stressed market (i.e., when banks face higher liquidity shocks). Our empirical results are directly related to the theoretical framework suggested by Castiglionesi et al. (2019), who analyze the effects of financial integration on the stability of the banking system. They propose that financial integration induces banks to reduce their liquidity holdings and shift their portfolios toward more-profitable but less-liquid investments. Further, they propose that financial integration leads to drastic interest rate spikes in times of crisis. Our study provides empirical evidence that is consistent with their theoretical expectations. Our paper also is related to Castiglionesi and Navarro (2020), who study the trade-off of a bank's increased connections in interbank markets (more diversification of liquidity risks vs. higher exposure to bankruptcy risks). Our study also is in line with Chavaz (2017), who empirically tests the relationship between banks' geographic diversification and their liquidity buffer. Our study is different from Chavaz, however, in the way that we measure financial integration. Although Chavaz employs geographic networks of bank branches, we introduce a novel measure of interbank business relationships as a proxy for financial integration.

In addition, our study contributes to empirical research on the determinants of bank liquidity creation. The seminal study by Berger and Bouwman (2009) provides comprehensive liquidity creation measures and examines the relationship between the equity ratio and bank liquidity creation. Following their measures, many studies empirically investigate the determinants of bank liquidity creation: regulatory interventions and capital support (Berger, Bouwman, Kick, and Schaeck, 2016), bank governance (Díaz and Huang, 2017), economic policy uncertainty (Berger, Guedhami, Kim, and Li, 2018), CEO optimism (Huang, Chen, and Chen, 2018), and bank competition (Choi, 2018; Jiang, Levine, and Lin, 2019). Our study contributes to the literature by showing that banks with more business partnerships decrease bank liquidity creation during market stress.

This paper is also a part of the literature that addresses how banks' liquidity shocks affect their lending activities (Bernanke and Blinder, 1992; Chava and Purnanandam, 2011; Drechsler et al., 2017; Gilje et al., 2016; Ivashina and Scharfstein, 2010; Kashyap and Stein, 2000; Khwaja and Mian, 2008; Loutskina and Strahan, 2009; Peek and Rosengren, 2000; Schnabl, 2012). Many of the papers mentioned above employ positive or negative shocks on the banks' funding or liquidity and examine how those shocks affect their lending activities afterward. Our paper also relates banks' liquidity problems to their loan origination for small business lending and mortgage during periods of market stress. This study contributes to the literature by identifying banks' reliance on interbank business partnerships as one of the underlying factors that differentiate banks' liquidity problems and subsequent lending activities in stressed markets.

The remainder of the paper is organized as follows. Section 2 presents the theoretical motivation and hypotheses. In Section 3, we describe the empirical methodology. Section 4 provides the data and summary statistics. The results of the empirical tests are provided in Section 5. Section 6 concludes.

2. Theoretical motivation

In this section, we describe the theoretical motivation for why banks tend to face severe liquidity problems if they have more relationships with business partners. Traditionally, banks relied on "stored liquidity" to manage their liquidity risk by increasing their liquid assets and reducing loans and other illiquid assets that account for most of their profitability. As an alternative, banks can control their liquidity risks by changing their liability structures toward long-term financing instead of short-term borrowing. Nevertheless, such a duration adjustment toward long-term financing also increases banks' overall funding costs and ultimately lowers their profitability because the funding costs of long-term debts are usually higher than those of short-term ones. This worsened profitability is a major disadvantage of banks' strict liquidity risk management.

Banks' conservative liquidity controls, such as holding more liquid assets and relying on long-term borrowing, however, can have benefits. This strategy enables banks to reduce the likelihood that they face severe liquidity shortfalls under bank-specific urgent liquidity demands. Once banks experience severe liquidity shortfalls, they can survive by issuing high-yield debts or conducting a fire sale of profitable long-term assets, which would severely lower their performance. Thus, strengthened liquidity risk management can protect banks' profitability by reducing their likelihood of suffering severe liquidity shortfalls. In this sense, liquidity risk management creates both benefits and costs for banks. By considering

[1] "Basel III: The liquidity coverage ratio and liquidity risk monitoring tools" (January 2013), which is available at https://www.bis.org/publ/bcbs238.pdf.

both the advantages and disadvantages, banks find their optimal level of liquidity risk management.

As documented by Castiglionesi et al. (2019), each bank's optimal liquidity control should differ, depending on its financing environment. Banks may rely on "purchased liquidity" instead of stored liquidity under favorable circumstances. If a bank has readily available external financing through the interbank market, it is less likely to face liquidity shortfalls, given a bank-specific liquidity shock, even without sufficient liquidity. In other words, the marginal benefit of the bank's strict liquidity control is reduced with a better funding environment. Accordingly, the favorable financing condition incentivizes the bank to loosen its costly liquidity risk control because lax liquidity management improves its profitability, while the likelihood of the bank's having a serious liquidity shortfall diminishes. By contrast, if an external financing condition is less favorable to a bank, its optimal liquidity risk management should be more conservative. For this bank, the marginal benefit of its stringent liquidity control is still sufficiently high.

One of the factors that differentiates each bank's external financing condition, given bank-specific urgent liquidity demands, is how actively the bank engages in interbank money market transactions. An increase in the bank's accessibility to the interbank money market results in an increase in the availability of short-term external financing to the bank. The abundant liquidity supply will weaken the bank's motivation to strengthen its liquidity control and ultimately increase its liquidity risk. The opposite, however, is possible, as well. If a bank's exposure to liquidity risks is growing, the bank might be strongly led to engage in interbank borrowing as an alternative to its liquidity risk control. In other words, simultaneous causality could exist between a bank's reliance on interbank funding and its liquidity risk. For this reason, we develop a new variable that well captures the interbank connection but is less influenced by the bank's current liquidity risk. This new measure is how many business partnerships the bank establishes with other financial institutions.

To identify interbank business partnerships, we turn to banks' arrangement of syndicated loans with participating financial institutions. We find that this new measure is positively correlated with the variable used to identify interbank funding relationships in the literature (Castiglionesi et al., 2014). The pre-existing business relationships established through syndicated loans enable the participating banks to be well aware of the asset quality of the lead arrangers. This will reduce information asymmetries between lead arrangers and their partners, which may facilitate lending from participating banks to the arranging banks when the lead arranger faces an urgent money demand. Moreover, the interbank lending market is an over-the-counter market, in which counterparties need to contact and negotiate with each other directly. It is not feasible to trade their liquidity if two parties have not known each other's presence and credibility. Thus, banks with such extensive partnerships are likely to easily overcome liquidity shocks by obtaining liquidity from the interbank market, even when they hold insufficient liquid assets. Ultimately, banks' growing relationships with business partners may incentivize them to loosen their costly liquidity risk management, as lax liquidity management can promote banks' profitability, while having more business partners can mitigate concerns about potential liquidity shocks.

Banks' lax liquidity risk management strategies in response to their extensive business partnerships work well as long as the market continues to function as expected. When money market transactions are sufficiently active to ensure that banks with urgent money demands can find counterparties to supply funds on time, liquidity-demanding banks encounter no liquidity problems and can enjoy higher profits by reducing liquidity holdings while expanding credit supply. Money market transactions are no longer active, however, if unprecedented adverse market-wide shocks affect the banking system similarly to those at the outset of the financial crisis. Financial institutions with idle money will not provide it to those with short-term liquidity demands due to the heightened uncertainty about the solvency of those counterparties. In such a frozen market, banks with urgent demands for funding face difficulties in obtaining additional liquidity from the money market despite having extensive business relationships with other financial institutions.

Banks with emergency funding demands have to survive market stress through their own liquidity, whereas banks with more business partnerships do not hold sufficient liquid assets to endure money market freezes. Having more relationships with business partners induces banks to rely on the liquidity purchased from the network comprised of such partnerships instead of storing liquidity, diminishing the liquid assets available at the outset of the crisis. Consequently, banks' high reliance on business partnerships collectively results in liquidity problems for the entire banking sector under an adverse market-wide shock. The liquidity problems will ultimately result in deteriorated liquidity creation and lending activities, particularly in those banks with more business partners. These liquidity problems are the unintended consequence of the financial integration highlighted by Castiglionesi et al. (2019).

3. Empirical methodology

3.1. Business partnership measurement

One of the key issues for our empirical tests is how to identify the number of a bank's business partnerships with financial institutions. To measure a bank's business relationships, we select an observable partnership: the relationships made through syndicated loan arrangements between the lead-arranging bank and participating financial institutions. In loan syndication, a lead arranger invites financial institutions that provide funds to the syndicated loan deal as participants. We assume that, if a lead arranger originates a deal and invites participants to the deal, a close business partnership is established between the lead arranger and participating institutions. We further hypothesize that pre-existing syndicated loan business partnerships mitigate the information asymmetries between the lead arranger and participants, increasing the likelihood of the former's borrowing from its business partners.

We use the number of relationships between a syndicated loan lead arranger and its participating financial institutions as a proxy for the number of the lead arranger bank's business partnerships. Specifically, we count and aggregate the number of relationships between the lead arranger and participants for all syndicated loan deals that originated during the last five years before the previous year (the same quarter-end) at the lead arranger bank's parent BHC level. We drop duplicated partnerships that have repeatedly joined several syndicated loan deals lead-arranged by the BHC during the past five years.[2] Then, the number of aggregated business partnerships is assigned to individual subsidiary banks under the same BHC. The natural logarithm of the number of aggregated business partnerships is used as a continuous variable that measures the number of a bank's business partnerships with financial institutions.

In constructing our partnership measure, we count only the number of partnerships established by a bank as the lead arranger of the syndicated loans. If the bank joins a syndicated loan as a participant, the bank's relationship with its lead arranger is not regarded as the partnership in this study. Our measure reflects the functional differences between the lead arranger and the participants in the process of the syndicated loan origination. The roles

[2] Our results are robust to keeping duplicated partnerships when measuring the number of the lead arranger's business partnerships.

of participants in syndicated loans are generally limited to the provision of funds. In contrast, the lead arranger assumes more extensive and crucial roles in managing the overall processes of the syndicated loan origination, including loan screening, covenant monitoring, and loan renegotiation afterward (e.g., Ivashina and Sun, 2011). The broader and deeper roles of a lead arranger imply that the participants entrust the lead arranger with the management of their funds for the syndication. Because information asymmetry between the lead arranger and the participant banks exists (e.g., Ivashina, 2009), the participants need to be aware of the arranger's managing ability, credibility, and financial soundness to mitigate the information asymmetry. In other words, the partnerships formed as lead arrangers are expected to be different from those constructed as participants in terms of their effectiveness in mitigating information asymmetry; the former is more effective than the latter. Hence, our measure counts only the syndicated loan partnerships established by a bank as a lead arranger with its participants.

3.2. Empirical design

In this paper, we focus on local banks that are subsidiaries of U.S. BHCs. Following Cortés (2015), a local bank is defined as a bank that collects more than 65% of its deposits from a single county. We do not include multi-regional banks in our sample because the liquidity constraints of those multi-regional banks (i.e., nationwide banks) can be contaminated by unobserved economic situations of various regions simultaneously. On the contrary, a local bank is assigned to a single county. A local bank's liquidity position will be directly affected by the local economic condition of a single region in which the majority of the bank's deposits are collected. Even though various types of unobserved local conditions still exist in each local market, those factors can be absorbed by time-county fixed effects, as each bank is matched to a specific county. For this reason, we limit our sample to local banks affiliated in U.S. BHCs.

In our empirical test, we relate the variables that measure banks' liquidity constraints to the number of their syndicated loan business partnerships during market stress. The regression model is as follows:

$$\begin{aligned} DepositRate_{i,m} = {} & \beta_0 + \beta_1 \log(NumPartnerships)_{i,m} \\ & + \beta_2 \log(NumPartnerships)_{i,m} \times Stress_m \\ & + \Gamma X_{i,m} + \delta_{m,c} + \delta_{i,c} + \epsilon_{i,m} \end{aligned} \quad (1)$$

The subscripts *i*, *m*, and *c* refer to the bank, month, and county, respectively. *DepositRate*, the outcome variable, is a bank's monthly average interest rate for a CD with a maturity of 12 months and an account size of 10,000 USD. Using *DepositRate*, we measure a bank's funding cost movement or its liquidity constraint in stressed markets. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between the lead arranger banks and financial institutions that take part in syndicated loans, which are arranged by the lead arranger bank's parent BHC during the last five years before the previous year (same quarter-end). *Stress* is a time dummy variable that identifies the month of the market stress. The periods of market stress are defined as the months within the sample period that have monthly average spreads of the CP's market yields against Treasury bill rates in the top 20%, following the approach used in Acharya and Mora (2015). As a robustness test, we replace the *Stress* dummy variable with a continuous variable, *Spread*, which is the monthly average spread between the yields on CPs and Treasury bills. As an extension, we assess how the regression results change if we drop the financial crisis period (from August 2007 to May 2009) from our sample.

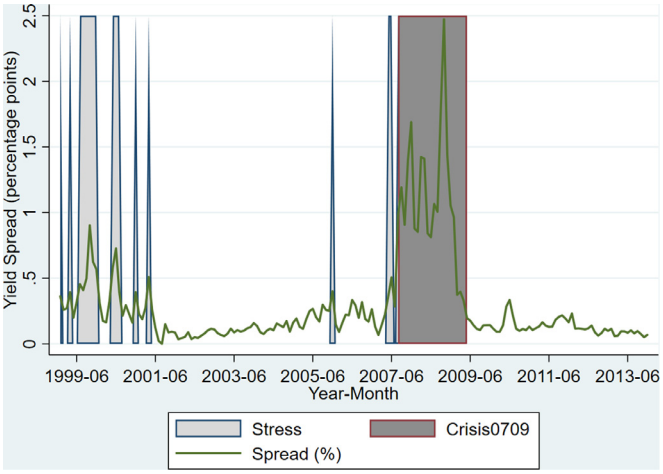

Fig. 2. Yield spread of three-month CPs against Treasury bills.
This figure presents the trend of the yield spread (percentage points) of three-month CP rates against Treasury bill rates from 1999 to 2013. It also presents the months of market stress, defined as the months that have a monthly average spread between the yields on CPs and Treasury bills in the top 20%. Months of market stress include the periods of "Crisis0709," which represents the period of the financial crisis (August 2007 to May 2009).

Fig. 2 provides a plot of the periods of *Stress* and the values of *Spread*. *X* is a set of BHC- and bank-level control variables, which control for each BHC's or each bank's specific characteristics that may be highly related to the bank's functioning in periods of market stress as well as to its interbank partnerships. The BHC-level control variables are Log*(BHCAsset)*, Log*(NumSyndicates)*, and Log*(AmtSyndicates)* for the bank's parent BHC. Bank-level controls are Log*(BankAsset)*, *Loan/Asset*, *Deposit/Liab*, *LeverageRatio*, *CapitalRatio*, *NPLRatio*, *MarketShare*, *C&I/Loan*, and *Z-score* of the local bank. Those control variables are measured at the previous quarter-end. For Log*(NumSyndicates)* and Log*(AmtSyndicates)*, the values are at the end of the same quarter of the previous year. The interactions between the above control variables and *Stress* or *Spread* are also included in the regressions as additional control variables. Appendix A provides a description of each variable. These control variables absorb the effect of banks' characteristics, such as existing asset or liability structures, and activeness of their syndicated loan arrangements on their liquidity constraints and ensure that our main coefficient captures only the effect of the number of banks' business partnerships on their liquidity problems in stressed markets. $\delta_{m,c}$ and $\delta_{i,c}$ indicate the month-county and bank-county fixed effects, respectively. These fixed effects enable us to completely absorb each region's (or county's) unique characteristics, such as local credit demand and economic state, as well as macroeconomic conditions (e.g., monetary policy effects), which may drive the regression results, and allow us to capture only the interbank variation among local banks within the same county at a given time.[3] Standard errors are clustered at the bank's parent BHC level.

[3] As documented in Kashyap and Stein (2000) and Merkl and Stolz (2009), monetary policy affects a bank's liquidity provision and lending activity. As a robustness check, we control for variables that measure monetary policy effects, such as the Boschen and Mills (1995) index, federal funds rate, and the Bernanke and Mihov (1998) index, similar to Kashyap and Stein, in untabulated results. The inclusion of these variables, however, does not affect our estimation results because the time-by-county fixed effect absorbs these macro-level time-series variables. As an alternative robustness, we control for the variables that measure monetary policy effects while excluding the time-by-county fixed effect. The results are robust to controlling for monetary policy effects. Those test results are reported in Table C.2 of the online appendix.

We next employ other sets of outcome variables that identify the spillover effects of a bank's liquidity constraints or the channel responsible for the bank's liquidity problems: *LiquidityCreation*, Log*(SmallBusinessLending)*, Log*(Mortgage)*, and *LCR*. For the regressions with *LiquidityCreation* and *LCR*, we convert all of the monthly variables into quarterly variables. For the regressions with Log*(SmallBusinessLending)* and Log*(Mortgage)*, we measure all the variables in the annual average basis. All other specifications are the same as in Eq. (1).

4. Data and summary statistics

4.1. Data source

For these empirical tests, we rely on several sets of data sources. First, we use the Dealscan database provided by Thomson Reuters LPC to identify each lead arranger bank's syndicated loan business partnerships with participating financial institutions. The Dealscan database contains information on syndicated loan packages, including lenders' and borrowers' identities. Following Chakraborty, Goldstein, and MacKinlay (2018), we select the lead arranger of each syndicated loan package and manually match the lead arrangers' names to the identifiers of the BHC in the Summary of Deposits, using the lead arrangers' names. From this matched dataset, we can count the number of relationships between the lead arranger and participating financial institutions for each syndicated loan package at the bank level as well as the aggregate number of relationships at the BHC level. We aggregate those numbers for the last five years up to the previous year based on the origination date of each package. Moreover, using Dealscan, we can identify the number of syndicated loan deals (package level) lead-arranged by a bank for the same period and the total aggregated dollar amounts of those deals, which are included as control variables in the regression analyses.

We collect and merge U.S. bank-level data from RateWatch, the Federal Reserve Bank of Chicago, the Federal Financial Institutions Examination Council, and the Federal Deposit Insurance Corporation. RateWatch provides the interest rates of various deposit products, including money market accounts and CDs. After converting the weekly deposit rates into monthly averages at the branch level, we calculate each bank's monthly average deposit rates. To identify adverse market-wide shocks, we measure the spread of three-month CP yields against Treasury bill rates. Both rates are available from Federal Reserve Economic Data. The Call Reports from the Federal Reserve Bank of Chicago contain banks' balance sheets, income statements, and off-balance-sheet activities. Based on the accounting information from these Call Reports, we calculate each bank's liquidity creation and estimate its LCR at each quarter-end. Bank-level control variables, such as total asset size, capital structure, and loan quality, also are collected from this data source.

Through the FR Y-9C from the Federal Reserve, we can identify BHC-level control variables, such as consolidated asset sizes. Our study also measures the small business lending and mortgage origination of each bank from the Federal Financial Institutions Examination Council. Moreover, the data provide information on the types of lending (e.g., retained by the originators vs. securitized) of each mortgage loan. From this information, we can analyze how banks' mortgage origination is affected by the number of their business partnerships in a stressed market for each type of lending (jumbo vs. non-jumbo mortgages and retained vs. securitized mortgages). These mortgage subcategories are explained in Section 5. Finally, we rely on the Summary of Deposits provided by the Federal Deposit Insurance Corporation to understand the geographic locations of bank branches. We identify local banks' main business areas using the information on the geographical spreads of bank branches.

4.2. Summary statistics

Table 1 presents the summary statistics for the key dependent and independent variables used in the empirical tests that relate banks' liquidity constraint (in terms of deposit interest rates, liquidity creation, and lending activities) to the number of their aggregated business partnerships with syndicated loan participants in stressed markets.

In Panel A, the first three rows provide banks' monthly average deposit interest rates. The average of banks' deposit interest rates is 2.298% for the full sample period (1999–2013). The mean values of banks' deposit interest rates fluctuate, depending on the periods. The mean value of deposit rates in the non-stress periods is 2.043%, whereas the value under market stress is 3.610%. If we convert the deposit interest rates into their spreads against risk-free rates, such as three-month Treasury bill rates, the difference in the spreads between non-stress and stress times also is significant. The mean value of deposit rate spreads against risk-free rates is 31 basis points for the full sample, but this value jumps to 66 basis points during times of market stress. The average value of deposit interest rate spreads decreases to 25 basis points in non-stress times.

The next line of the same panel contains the summary statistics of all other outcome variables that include *LiquidityCreation*, Log*(SmallBusinessLending)*, Log*(Mortgage)*, and *LCR*. Next, Log*(NumPartnerships)* is the main independent variable of our tests, capturing the number of each bank's aggregated business partnerships with financial institutions established through its syndicated loan arrangements. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between the lead arranger bank and participating financial institutions at the bank's parent BHC level for the last five years until the previous year. The BHC-level variables include Log*(BHCAsset)*, Log*(NumSyndicates)*, and Log*(AmtSyndicates)*. Bank-specific characteristics are controlled for by the variables of Log*(BankAsset), Loan/Asset, Deposit/Liab, LeverageRatio, CapitalRatio, NPLRatio, MarketShare, C&I/Loan*, and *Z-score*. As noted, Appendix A provides a description of the variables.

Panel B presents the results of the univariate tests for the mean values of the variables between banks with syndicated loan business partnerships and banks without such business partnerships. The univariate test results are consistent even when the cutoff for the number of business partnerships increases from zero to above ten. According to the univariate test results, banks with business partnerships tend to maintain lower deposit rates, create more liquidity, and originate more lending in normal times than do banks with no such business partnerships. The univariate test results, however, change dramatically in periods of market stress. We can no longer find significant differences in deposit interest rates and loan origination between the two types of banks in stressed markets. Regarding the tests for control variables, the banks with business partnerships tend to be larger in their consolidated BHC assets or total assets than are banks without such business partnerships. Banks with syndicated loan business partnerships are more likely to have a lower proportion of their total loans among total assets, a lower proportion of total deposits among total liabilities, higher capital ratios, and lower non-performing loan ratios. As noted, we limit samples to local banks. The local banks are assigned to one single U.S. county where the banks collect more than 65% of their deposits.

One caveat in interpreting the univariate test results is that both the outcome variable and the partnership measure may be highly correlated with regional economic conditions that surround the banks as well as with the banks' characteristics. The univariate test results did not control for the effects of local economic situations and bank-specific characteristics on those variables. For

Table 1
Summary statistics and univariate test results.
Panel A presents the summary statistics for the key regression variables. The sample period runs from 1999 to 2013. Panel B provides the results of the univariate test of the mean values of the variables between banks with at least one relationship with other financial institutions through syndicated loan arrangements and banks without such a relationship in regard to significant differences. Appendix A provides a description of each variable. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A

				Percentile Distribution		
Variable	*n*	Mean	SD	25th	Median	75th
DepositRate (total)	23,573	2.298	1.585	1.000	1.972	3.437
DepositRate (Stress = 0)	19,739	2.043	1.510	0.800	1.612	3.000
DepositRate (Stress = 1)	3834	3.610	1.290	2.500	3.520	4.600
LiquidityCreation (total)	9077	0.413	0.193	0.310	0.419	0.517
LiquidityCreation (Stress = 0)	7403	0.409	0.186	0.306	0.413	0.512
LiquidityCreation (Stress = 1)	1674	0.432	0.220	0.332	0.443	0.535
Log(SmallBusinessLending) (total)	991	10.874	1.181	10.208	10.900	11.533
Log(SmallBusinessLending) (Stress = 0)	820	10.858	1.196	10.198	10.878	11.536
Log(SmallBusinessLending) (Stress = 1)	171	10.948	1.109	10.332	10.954	11.491
Log(Mortgage) (total)	1744	10.244	1.620	9.223	10.255	11.287
Log(Mortgage) (Stress = 0)	1440	10.251	1.662	9.184	10.250	11.357
Log(Mortgage) (Stress = 1)	304	10.214	1.402	9.429	10.339	11.095
LCR (total)	4806	2.261	2.805	0.554	1.072	2.578
LCR (Stress = 0)	3874	2.465	2.967	0.600	1.193	2.898
LCR (Stress = 1)	932	1.415	1.762	0.432	0.757	1.547
Log(NumPartnership)	23,573	0.130	0.655	0.000	0.000	0.000
Log(BHCAsset)	23,573	13.861	1.319	12.878	13.565	14.656
Log(NumSyndicates)	23,573	0.136	0.602	0.000	0.000	0.000
Log(AmySyndicates)	23,573	1.318	5.075	0.000	0.000	0.000
Log(BankAsset)	23,573	13.244	1.101	12.463	13.178	13.814
Loan/Asset	23,573	0.683	0.130	0.607	0.699	0.771
Deposit/Liab	23,573	0.901	0.093	0.864	0.928	0.967
LeverageRatio	23,573	0.090	0.027	0.076	0.085	0.097
CapitalRatio	23,573	0.137	0.043	0.111	0.125	0.149
NPLRatio	23,573	0.021	0.033	0.003	0.008	0.022
MarketShare	23,573	0.030	0.046	0.004	0.014	0.039
C&I/Loan	23,573	0.175	0.120	0.086	0.156	0.240
Z-score	23,573	31.311	24.098	12.314	26.922	44.330

Panel B

	With Partnerships		No Partnerships		Mean Difference	
Variable	Mean	Median	Mean	Median	(*t*-statistic)	
DepositRate (total)	2.185	1.687	2.303	1.990	−0.118*	(−2.37)
DepositRate (Stress = 0)	1.865	1.193	2.051	1.635	−0.186***	(−3.54)
DepositRate (Stress = 1)	3.528	3.250	3.615	3.540	−0.087	(−0.94)
LiquidityCreation (total)	0.571	0.511	0.408	0.416	0.163***	(14.89)
LiquidityCreation (Stress = 0)	0.552	0.508	0.404	0.410	0.148***	(12.23)
LiquidityCreation (Stress = 1)	0.635	0.554	0.423	0.440	0.212***	(8.15)
Log(SmallBusinessLending) (total)	11.857	12.271	10.789	10.838	1.068***	(7.95)
Log(SmallBusinessLending) (Stress = 0)	12.007	12.357	10.763	10.818	1.244***	(8.25)
Log(SmallBusinessLending) (Stress = 1)	11.269	11.206	10.915	10.940	0.354	(1.22)
Log(Mortgage) (total)	11.481	11.633	10.184	10.206	1.297***	(7.14)
Log(Mortgage) (Stress = 0)	11.706	11.970	10.181	10.183	1.525***	(7.42)
Log(Mortgage) (Stress = 1)	10.491	10.706	10.199	10.320	0.291	(0.78)
LCR (total)	3.171	1.463	2.212	1.062	0.958***	(5.23)
LCR (Stress = 0)	3.468	1.735	2.415	1.181	1.054***	(4.73)
LCR (Stress = 1)	2.267	1.042	1.355	0.744	0.912***	(3.94)
Log(BHCAsset)	16.513	16.944	13.736	13.502	2.777***	(74.53)
Log(BankAsset)	14.848	15.198	13.168	13.151	1.680***	(51.28)
Loan/Asset	0.637	0.661	0.685	0.701	−0.049***	(−11.93)
Deposit/Liab	0.839	0.875	0.904	0.929	−0.065***	(−22.39)
LeverageRatio	0.094	0.082	0.090	0.085	0.004***	(4.96)
CapitalRatio	0.150	0.126	0.136	0.125	0.014***	(10.32)
NPLRatio	0.017	0.008	0.021	0.008	−0.004***	(−3.86)
MarketShare	0.070	0.039	0.028	0.014	0.041***	(29.36)
C&I/Loan	0.296	0.280	0.169	0.153	0.127***	(34.66)
Z-score	25.431	17.200	31.589	27.418	−6.158***	(−8.15)

this reason, our regressions include the time-by-county fixed effects that enable us to completely absorb the regional economic situations that may drive the differences in the mean values of our key outcome variables between more-partnered and less-partnered banks. Further, we add the control variables at the BHC and bank levels listed in Table 1 to control for the potential fundamental differences between the banks with a large number of business partnerships and those without such a large number of business partnerships.

5. Empirical results

In this section, we present the empirical results in regard to business partnership and funding costs, business partnership and

Table 2
Bank partnership and funding cost during market stress.
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its deposit funding costs, given market-wide stress. *DepositRate* is the deposit interest rate for CDs with account sizes of 10,000 USD and a 12-month maturity. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of the same quarter of the previous year. *Stress* is a time dummy variable that identifies a month of market stress that is within the top 20%, measured by the monthly average spread between the yields on CPs and Treasury bills. *Spread* is the monthly average spread between the yields on CPs and Treasury bills. *Crisis0709* is a time dummy variable that identifies the financial crisis (August 2007 to May 2009). This regression includes the BHC-level and bank-level control variables listed in Table 1 at the previous quarter-end. For Log*(NumSyndicates)* and Log*(AmtSyndicates)*, the values are at the end of the same quarter of the previous year. The interactions between the above control variables and *Stress* (or *Spread*) also are included in the regressions as additional control variables. For brevity, the coefficients of these control variables are not reported. Appendix A provides a description of each variable. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	DepositRate					
	All			*Crisis0709* = 0		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.168***	−0.191***	−0.194***	−0.223***	−0.236***	−0.265***
	(−2.98)	(−3.33)	(−3.29)	(−4.09)	(−4.20)	(−4.01)
Log(NumPartnerships) × *Stress*		0.104**			0.170***	
		(2.16)			(2.80)	
Log(NumPartnerships) × *Spread*			0.077			0.329*
			(1.30)			(1.69)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Month-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23,573	23,573	23,573	20,947	20,947	20,947
Adjusted R^2	0.962	0.962	0.962	0.966	0.966	0.966

liquidity creation, business partnership and small business lending, business partnership and mortgage origination, and business partnership and liquidity, all in the context of stressed markets.

5.1. Business partnership and funding cost in stressed markets

Table 2 presents the relationship between banks' business partnerships and funding costs during market stress, as drawn from the results of the regressions described in Eq. (1). Each bank's monthly average deposit interest rates are used as the outcome variable. In Column 2, we include a time dummy variable (*Stress*) in the regressions to identify market stress. The regression results show that the interaction term of Log*(NumPartnerships)* × *Stress* is positive and statistically significant (Column 2). The coefficient of 0.104 in Column 2 means that, if the number of a bank's business partnership increases by 1%, the bank's deposit funding costs increase by around 0.104 basis points in a stressed market. If banks are affiliated with the BHCs that have relationships with more business partners through syndicated loan arrangements in the previous five years, those local banks are more likely to suffer from high deposit interest rates in months of market stress. In other words, if a bank has more relationships with syndicated loan business partners, it is more likely to face a more-severe funding problem during a liquidity crisis. In Column 3, we replace *Stress* with a continuous variable, *Spread*, which represents the spread of the monthly average market yields on CPs against risk-free rates. In Columns 4–6, we exclude the samples of the periods that correspond to the financial crisis. Even after dropping these unusual crisis times, our main coefficients are positive and statistically significant.

The coefficients reported in this table also are economically significant. The estimated values of Log*(NumPartnerships)* × *Stress* are 10 to 17 basis points, which are approximately 4–8% of the mean value of monthly average deposit interest rates during the sample period. A one-standard-deviation increase in Log*(NumPartnerships)* is associated with a 7-basis-point increase in banks' deposit interest rates in times of market stress.

As a robustness check, we run the same regressions but limit samples to the pre-crisis period. During the financial crisis, unconventional monetary policies (Quantitative Easing and Troubled Asset Relief Program) as well as unprecedented financial regulatory reforms (Dodd-Frank Act and Basel III) were introduced. These regulatory changes may make a significant structural difference to the liquidity condition in the banking system relative to that in the pre-crisis period. The financial crisis itself should also be a devastating shock on the market liquidity. For this reason, we conduct the sub-sample regression for the pre-crisis period. Our results are robust to the sub-sample regression. Those test results are reported in Table C.1 of the online appendix.

5.2. Business partnership and liquidity creation in stressed markets

In the previous subsection, we showed that banks with more business partnerships are more likely to experience higher funding costs during market stress. If a bank suffers from a liquidity shock or funding problem, this adversely influences its liquidity provision to the economy.[4]

In this subsection, we present the results related to our investigation of how the number of banks' business partnerships relates to their liquidity creation during market stress. Following Berger and Bouwman (2009), we use the "cat fat" measure as our liquidity creation variable. This category-based liquidity creation measure includes off-balance-sheet activities in a notion that the category-based loan classification is more reasonable than is the maturity-based loan classification. For example, the maturity-based classification considers some business loans to be liquid even though business loans are difficult to dispose of by their nature. In contrast, the category-based classification treats all business loans as illiquid. Further, liquidity creation via off-balance-sheet items is crucial, particularly in large BHCs (Berger and Bouwman, 2009). Because our sample banks are the subsidiaries of

[4] Acharya and Mora (2015) document that, although U.S. banks faced rapid withdrawal of credit lines during the financial crisis, their liquidity provision severely deteriorated without strong support from the government. Cornett et al. (2011) show that banks that held more illiquid assets reduced their credit supply during the financial crisis. Kashyap and Stein (2000) and Khwaja and Mian (2008) highlight how adverse liquidity shocks on banks reduced their loan origination.

Table 3
Bank partnership and liquidity creation during market stress.
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its liquidity creation, given market-wide stress. *LiquidityCreation* is a bank's liquidity creation. In Panel A, we use total bank liquidity creation as the dependent variable. In Panel B, we use bank off-balance-sheet liquidity creation as the dependent variable. L*og(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of the same quarter of the previous year. *StressQ* is a time dummy variable that identifies a quarter of market stress that is within the top 20%, measured by the quarterly average spread between the yields on CPs and Treasury bills. *SpreadQ* is the quarterly average spread between the yields on CPs and Treasury bills. *Crisis0709* is a time dummy variable that identifies the financial crisis (August 2007 to May 2009). This regression includes the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported. Appendix A provides a description of each variable. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A

	LiquidityCreation					
	All			*Crisis0709* = 0		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.017	−0.004	−0.002	−0.003	0.003	0.022
	(−1.04)	(−0.23)	(−0.13)	(−0.16)	(0.18)	(0.99)
Log(NumPartnerships) × *StressQ*		−0.045**			−0.045**	
		(−2.59)			(−2.07)	
Log(NumPartnerships) × *SpreadQ*			−0.042**			−0.117**
			(−2.38)			(−2.07)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5960	5960	5960	5324	5324	5324
Adjusted R^2	0.928	0.931	0.931	0.927	0.928	0.928

Panel B

	OBS-side LC					
	All			*Crisis0709* = 0		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.001	0.006	0.007	0.004	0.007	0.009
	(−0.22)	(0.82)	(0.87)	(0.50)	(0.89)	(1.06)
Log(NumPartnerships) × *StressQ*		−0.027**			−0.024**	
		(−2.57)			(−2.25)	
Log(NumPartnerships) × *SpreadQ*			−0.026**			−0.022
			(−2.13)			(−1.19)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Quarter-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5960	5960	5960	5324	5324	5324
Adjusted R^2	0.971	0.972	0.972	0.969	0.969	0.969

BHCs, we consider off-balance-sheet activities by using the cat fat measure. The liquidity creation variables are normalized by banks' total assets at each quarter-end. Thus, we redesign our regression formula on a quarterly basis, as follows:

$$\begin{aligned} LiquidityCreation_{i,q} = {} & \beta_0 + \beta_1 \log(NumPartnerships)_{i,q} \\ & + \beta_2 \log(NumPartnerships)_{i,q} \times StressQ_q \\ & + \Gamma X_{i,q} + \delta_{q,c} + \delta_{i,c} + \epsilon_{i,q} \end{aligned} \quad (2)$$

In this equation, the subscript q refers to the quarter. *StressQ* is a time dummy variable that identifies a market-stressed quarter, and $\delta_{q,c}$ is the quarter-county fixed effects.

Table 3 provides the regression results. In Panel A, the interaction terms of L*og(NumPartnerships)* × *StressQ* are negative and statistically significant in all of the columns, regardless of whether we drop the samples of the financial crisis. These results imply that, if local banks have more business partnerships with financial institutions through syndicated loan arrangements, they are more likely to reduce liquidity creation in market-stressed quarters. The estimated value of −0.045 in Column 2 implies that, if the number of a bank's business partnerships increases by 1%, the bank's liquidity creation decreases by 4.5 basis points in the stressed market. In Columns 3 and 6, we replace the time dummy variable, *StressQ*, with a continuous variable, *SpreadQ*, which measures the quarterly average spread of market CP yields against risk-free rates. The estimated values of L*og(NumPartnerships)* × *SpreadQ* are still negative and statistically significant in all of the columns.

The regression results are economically significant. The magnitude of L*og(NumPartnerships)* × *StressQ* is −0.045. Its absolute value is around 11% of the mean value of banks' quarterly liquidity creation during the sample period. A one-standard-deviation increase in L*og(NumPartnerships)* is associated with a 7% decrease in banks' liquidity creation relative to their total assets compared with its mean in a stressed market.

The results in Panel B concern bank off-balance-sheet liquidity creation. We find that off-balance-sheet activities mainly drive the negative relationship between a bank's number of partnerships and the bank's liquidity creation during periods of market stress. The results in Panel B shows that banks with more partnerships are more likely to reduce their liquidity creation through off-balance-sheet activities. In contrast, in unreported results, we find that most of the interaction terms are statistically insignificant for asset- and liability-side liquidity creation. The different results between off-balance-sheet and on-balance-sheet activities suggest

Table 4
Bank partnership and small business lending during market stress.
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its small business lending, given market-wide stress. Log*(SmallBusinessLending)* is the natural log of a bank's aggregated small business lending during a year. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of June of the previous year. *StressY* is a time dummy variable that identifies a year of market stress that is within the top 20%, measured by the annual average spread between the yields on CPs and Treasury bills. *SpreadY* is the annual average spread between the yields on CPs and Treasury bills. *Year08* is a time dummy variable that identifies 2008. This regression includes the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Log (SmallBusinessLending)					
	All			*Year08* = 0		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	0.025	0.101	0.108	0.004	0.060	0.168
	(0.29)	(1.06)	(0.97)	(0.04)	(0.49)	(1.17)
Log(NumPartnerships) × *StressY*		−0.203**			−0.364***	
		(−1.98)			(−3.28)	
Log(NumPartnerships) × *SpreadY*			−0.210			−0.548
			(−1.58)			(−1.52)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	991	991	991	928	928	928
Adjusted R^2	0.848	0.848	0.848	0.843	0.843	0.844

that those with more business partnerships adjust their liquidity creation via off-balance-sheet activities rather than by the liquidity creation via asset- and liability-side activities in stressed markets. The results are robust to the restricted samples that exclude the financial crisis period and the entire post-crisis period.

5.3. Business partnership and small business lending in stressed markets

As a next step, we test how a bank's origination of small business lending is affected by the number of its syndicated loan partnerships in stressed markets. In this test, we use the log of annual aggregated small business lending originated by each local bank Log*(SmallBusinessLending*) as the outcome variable. We convert the monthly or quarterly value into an annual basis because each bank's aggregated small business lending origination is available at a yearly level:

$$\begin{aligned} &log(SmallBusinessLending)_{i,y} \\ &= \beta_0 + \beta_1 \log(NumPartnerships)_{i,y} \\ &\quad + \beta_2 \log(NumPartnerships)_{i,y} \times StressY_y \\ &\quad + \Gamma X_{i,y} + \delta_{y,c} + \delta_{i,c} + \epsilon_{i,y} \end{aligned} \tag{3}$$

In this equation, the subscript y refers to the year. *StressY* is a time dummy variable that identifies the years of market stress, and $\delta_{y,c}$ is the year-county fixed effects. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships with financial institutions that participate in syndicated loan deals arranged by banks' parent BHCs during the five years before the end of the previous June.

Table 4 presents the regression results. The estimated value of the interaction term, Log*(NumPartnerships)* × *StressY*, is negative and statistically significant, as seen in Column 2. The coefficient of −0.203 in the second column means that, if the number of a bank's business partnerships increases by 1%, the bank's small business lending decreases by 0.203% in stressed markets. For this year-bank-level panel regression, the year 2008 is defined as the financial crisis period.[5] Even when we remove the financial crisis period from the sample, the interaction terms are significant both economically and statistically, as reported in Column 5.

The regression results also are economically significant. A one-standard-deviation increase in Log*(NumPartnerships)* is related to a 1.2% decrease in banks' small business loan origination relative to its mean value in a stressed market. Overall, our regression results imply that banks with more business partnerships are more likely to reduce their origination of small business lending in stressed markets. In Columns 3 and 6, we replace the *StressY* dummy with *SpreadY*, which is the annual average spread of the yield on CPs against risk-free rates. Our regression results are robust under the specification with the continuous variable instead of the indicator variable.

5.4. Business partnership and mortgage origination in stressed markets

Now, we focus on the relationship between a bank's number of partners and the bank's mortgage origination during a period of market stress. For this test, we employ the natural log of each bank's aggregated mortgage origination in each year, Log*(Mortgage)*, as the dependent variable. As in the small business lending regressions, each bank's aggregated mortgage origination is available at an annual frequency. Except for the outcome variable, we use the same regression specifications as in Eq. (3).

Table 5 provides the regression results for banks' mortgage origination in stressed markets. We find that the interaction terms of Log*(NumPartnerships)* × *StressY* and Log*(NumPartnerships)* × *SpreadY* are negative and significant in all of the columns. The coefficient of −0.562 in the second column suggests that, if the number of a bank's business partnerships increases by 1%, the bank's mortgage lending decreases by 0.562% in a stressed market.

Regarding the results for banks' mortgage origination, we find that mortgages are considered to be less susceptible to banks' liquidity constraints due to their high likelihood of securitization. If

[5] The annual average spread of CP yields against risk-free rates in 2008 is almost twice that in 2007 and more than four times that of 2009.

Table 5
Bank partnership and mortgage origination during market stress.
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its mortgage origination, given market-wide stress. Log*(Mortgage)* is the natural log of a bank's aggregated mortgage origination during a year. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC"s syndicated loan arrangements during the five years before the end of June of the previous year. *StressY* is a time dummy variable that identifies a year of market stress that is within the top 20%, measured by the annual average spread between the yields on CPs and Treasury bills. *SpreadY* is the annual average spread between the yields on CPs and Treasury bills. *Year08* is a time dummy variable that identifies 2008. This regression includes the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Log(Mortgage)					
	All			*Year08* = 0		
	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.421*	−0.342	−0.278	−0.325	−0.283	−0.122
	(−1.68)	(−1.35)	(−1.03)	(−1.28)	(−1.15)	(−0.50)
Log(NumPartnerships) × *StressY*		−0.562**			−0.550**	
		(−2.24)			(−2.21)	
Log(NumPartnerships) × *SpreadY*			−0.628**			−1.173*
			(−2.33)			(−1.82)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1744	1744	1744	1626	1626	1626
Adjusted R^2	0.794	0.797	0.796	0.797	0.801	0.800

a bank can easily securitize its mortgages in the market, its mortgage origination is not severely interrupted by its funding issues. Thus, we predict that, even if banks with more business partnerships face more-severe liquidity shocks during market stress, they are less likely to face constraints in their mortgage origination, particularly for those mortgages that are more likely to be securitized.

To further test this hypothesis, we decompose mortgages into jumbo and non-jumbo loans. The Federal Housing Finance Agency has set a loan limit, below which government-sponsored enterprises, such as the Federal National Mortgage Association (Fannie Mae) and Federal Home Loan Mortgage Corporation (Freddie Mac), are allowed to purchase mortgages from loan originators. Jumbo mortgages—mortgages above the loan limit—are more difficult to securitize in the market because government-sponsored enterprises are not allowed to purchase them. For this reason, jumbo mortgages are more likely to be retained by the originating bank and are expected to be more sensitive to the originator's liquidity shocks than are non-jumbo mortgages (Loutskina and Strahan, 2009). Thus, we compare the relationship between the number of a bank's business partnerships and the bank's origination of jumbo mortgages with that of non-jumbo mortgages.

The results, presented in Table 6, show that the interaction terms, Log*(NumPartnerships)* × *StressY* and Log*(NumPartnerships)* × *SpreadY*, have negative and significant coefficients for jumbo mortgages, whereas the coefficients are insignificant for non-jumbo mortgages. The results for jumbo mortgages are also economically significant. A one-standard-deviation increase in Log*(NumPartnerships)* is associated with a more than 3% decrease in banks' jumbo mortgage origination in stressed markets. These regression results imply that banks with more business partnerships are likely to reduce their mortgage loan origination only if lending is susceptible to their funding problems in stressed markets.

We further decompose mortgages into retained and sold mortgages and compare the effects on banks' mortgage origination in stressed markets for these two sub-categories. We expect that retained mortgages are more sensitive to the bank's liquidity shocks than are securitized mortgages (Gilje et al., 2016). The regression results in Table 7 indeed confirm that the estimated values of both interaction terms, Log*(NumPartnerships)* × *StressY and* Log*(NumPartnerships)* × *SpreadY*, are negative and significant only for retained mortgages. The coefficients are insignificant for sold mortgages. These results are consistent with those in Table 6. In other words, banks with more business partnerships tend to reduce their lending in stressed markets, particularly if these loans are expected to be retained in the banks, and, thus, they are more sensitive to liquidity shocks than are the potential securitized loans.

In SubSections 5.2 through 5.4, we report that banks with extensive business partnerships are more likely to reduce their liquidity creation and lending than are banks without such partnerships. These test results are against the alternative hypothesis that more partnered banks are likely to face higher loan demands from borrowers in stressed markets, which may exacerbate the liquidity problems of those banks. Moreover, the adverse effect of partnerships on lending activities is prominent if the lending activities are highly sensitive to the available funding.

5.5. Business partnership and liquidity risk management

In this subsection, we identify the channel through which banks with more partners suffer more liquidity problems than do less partnered banks, particularly in stressed markets. Castiglionesi et al. (2019) document that banks that have better accessibility to short-term interbank financing are incentivized to loosen their liquidity risk controls by holding lower reserves of safe liquid assets and expanding less-liquid and more-risky assets. This ultimately leads to a reduction of total liquid resources in the integrated banking system under systemic shocks. Based on this theoretical motivation, we investigate whether business partnerships among banks affect their incentive to manage liquidity risk.

To examine the liquidity risk management of banks, we estimate their LCRs. An LCR refers to the stock of HQLAs held by a bank proportional to its expected net cash outflows over the next 30 days. The measure indicates a bank's short-term ability to withstand a sudden withdrawal of funds. Because the definition and requirements of an LCR were initially introduced in 2010, LCR data are not publicly available in our sample period. Instead, we estimate the measure using the publicly available information in the Call Report similarly to Hong et al. (2014). Appendix B presents the construction of an LCR from the variables in the Call Report. We then examine the relationship between a bank's partnerships and

Table 6
Bank partnership and mortgage origination during market stress (jumbo vs. non-jumbo).
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its mortgage origination, given market-wide stress. We compare the mortgage origination of jumbo and non-jumbo mortgages. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of June of the previous year. *StressY* is a time dummy variable that identifies a year of market stress that is within the top 20%, measured by the annual average spread between the yields on CPs and Treasury bills. *SpreadY* is the annual average spread between the yields on CPs and Treasury bills. This regression includes the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Log(Mortgage)					
	Jumbo mortgages			Non-Jumbo mortgages		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.066	0.044	0.265	−0.442*	−0.428	−0.465
	(−0.37)	(0.21)	(1.32)	(−1.65)	(−1.45)	(−1.43)
Log(NumPartnerships) × *StressY*		−0.485**			−0.320	
		(−2.04)			(−1.20)	
Log(NumPartnerships) × *SpreadY*			−0.961***			−0.200
			(−3.20)			(−0.65)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1641	1641	1641	1732	1732	1732
Adjusted R^2	0.711	0.714	0.716	0.809	0.811	0.811

Table 7
Bank partnership and mortgage origination during market stress (retained vs. sold).
This table presents the results for the relationship between the number of a bank's syndicated loan business partnerships with participating financial institutions and its mortgage origination, given market-wide stress. We compare the mortgage origination of retained and sold mortgages. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of June of the previous year. *StressY* is a time dummy variable that identifies a year of market stress that is within the top 20%, measured by the annual average spread between the yields on CPs and Treasury bills. *SpreadY* is the annual average spread between the yields on CPs and Treasury bills. This regression includes the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported Appendix A provides a description of each variable. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Log(Mortgage)					
	Retained mortgages			Sold mortgages		
	(1)	(2)	(3)	(4)	(5)	(6)
Log(NumPartnerships)	−0.179	−0.057	0.020	−0.574	−0.452	−0.398
	(−1.09)	(−0.35)	(0.11)	(−1.15)	(−0.92)	(−0.69)
Log(NumPartnerships) × *StressY*		−0.657**			−0.690	
		(−2.32)			(−0.66)	
Log(NumPartnerships) × *SpreadY*			−0.697**			−0.549
			(−2.03)			(−0.46)
BHC controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1738	1738	1738	936	936	936
Adjusted R^2	0.772	0.775	0.774	0.754	0.755	0.754

its LCR. Because we estimate a bank's LCR using their quarterly financial statements, we construct a quarter-bank panel sample and design the regression equation as follows:

$$LCR_{i,q} = \beta_0 + \beta_1 \log(NumPartnerships)_{i,q} + \Gamma X_{i,q} + \delta_{q,c} + \delta_{i,c} + \epsilon_{i,q} \quad (4)$$

Panel A of Table 8 presents the regression results. In these regressions, the central coefficient of interest is Log *(NumPartnerships)*. We use the full sample in Column 1, whereas we limit the sample to non-stress periods and stress periods in Columns 2 and 3, respectively. A stress period identifies a quarter of market stress that is within the top 20%, measured by the quarterly average spread between yields on CPs and Treasury bills. Log*(NumPartnerships)* has a negative and statistically significant coefficient in the first column. Interestingly, the coefficient is significant only in the non-stress period (Column 2); it is insignificant in periods of market stress (Column 3). These results are also economically significant. The coefficient of −1.027 in Column 1 means that, if the number of a bank's business partnerships increases by an additional 1%, the bank reduces its LCR by 1.027% points. A one-standard-deviation increase in Log*(NumPartnerships)* is associated with a 30% decrease in a bank's LCR relative to its mean value. A lower LCR means banks hold less or possibly insufficient HQLAs relative to their expected net cash outflows in the next 30 days under stressed market conditions. In other words, banks take more liquidity risk if they are partnered with more institutions. From these regression results, we conclude that banks with more partnerships are more likely to loosen their liquidity risk management, which may lead to more-severe liquidity problems for those banks during a period of market stress.

As the last stage, we investigate the relationship between a bank's LCR and its deposit funding costs during a period of market stress to clarify the channel responsible for more-severe liquidity constraints on more partnered banks. In this test, we em-

Table 8
Bank partnership and liquidity coverage ratio.
Panel A presents the results for the relationship between the number of a bank's syndicated loan business partnership with participating financial institutions and its proforma liquidity coverage ratio (LCR), which is its estimated Basel III LCR. Log*(NumPartnerships)* is the natural log of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of the same quarter of the previous year. Column 1 includes the full sample period. Columns 2 and 3 include the samples from the non-stress and stress periods, respectively. A stress period identifies a quarter of market stress that is within the top 20%, measured by the quarterly average spread between the yields on CPs and Treasury bills. Panel B presents the results for the relationship between a bank's proforma LCR and its deposit funding costs, given market-wide stress. *HighLCR* is a dummy variable that equals 1 if the annual average of a bank's quarterly LCRs during past four quarters until the previous quarter-end belongs to top 25%, and 0 if the value belongs to bottom 25%. Except for replacing Log*(NumPartnerships)* with *HighLCR*, all other regression specifications are same as those used in Table 2. In both panels, the regressions include the BHC-level and bank-level control variables in Table 2. For brevity, the coefficients of these control variables are not reported Appendix A provides a description of each variable. Standard errors are clustered at the BHC level; *t*-statistics are in parentheses. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A

	LCR		
Variable	Full sample period (1)	Non-stress period (2)	Stress period (3)
Log(NumPartnerships)	−1.027**	−1.424***	−0.677
	(−2.55)	(−2.82)	(−0.91)
BHC controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Quarter-County FE	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes
Observations	4806	4082	724
Adjusted R^2	0.681	0.696	0.687

Panel B

	DepositRate		
Variable	(1)	(2)	(3)
HighLCR	0.042	0.095	0.117
	(0.55)	(1.16)	(1.42)
HighLCR × *Stress*		−0.258**	
		(−2.23)	
HighLCR × *Spread*			−0.222**
			(−2.38)
BHC controls	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes
Month-County FE	Yes	Yes	Yes
Bank-County FE	Yes	Yes	Yes
Observations	6842	6842	6842
Adjusted R^2	0.949	0.950	0.950

ploy the same regression setting used in Table 2, except we replace Log*(NumPartnerships)* with *HighLCR* as the main independent variable. *HighLCR* is a dummy variable that takes a value of 1 if the annual average of a bank's quarterly LCRs from the past four quarters to the previous quarter-end belongs to the top 25%, and 0 if the value belongs to the bottom 25%. The regression results are reported in Panel B of Table 8. The interaction terms, *HighLCR* × *StressY* and *HighLCR* × *SpreadY*, have negative and statistically significant coefficients. The results highlight that banks with lower LCRs are more likely to face severe liquidity constraints in the stressed market in terms of deposit funding costs. By showing the negative relationships between the number of banks' business partnerships and their estimated LCRs, we identify one channel through which banks with extensive partnerships tend to face liquidity constraints in stressed markets; namely, these banks are more likely to loosen their liquidity risk management, as revealed by their estimated LCRs.

The results provided in Table 8 have a vital policy implication. In a world of financial integration, the liquidity requirements from the Basel III Accord may help prevent liquidity crises. The increasing number of partnerships among banks leads to financial integration, in which banks have incentives to co-insure their liquidity risks by relying on purchased liquidity rather than stored liquidity. As a result, banks become vulnerable to sudden liquidity shocks in which they are barely able to match their liquidity supply and demand. If, however, banks were required to hold sufficient liquidity proposed by liquidity requirements, such as an LCR, they might not have experienced a surge in funding costs that could result in those institutions' serial defaults observed during the financial crisis.

6. Conclusion

This study examines the relationship between banks' business partnerships with syndicated loan participants and their vulnerability to liquidity shocks in stressed markets. In our analyses, we use banks' aggregated number of relationships with participating financial institutions formed through syndicated loan arrangements as a proxy for the number of their business partnerships with financial institutions. We show that, as banks have extensive business partnerships with syndicated loan participants, they are more likely to suffer from increased funding costs, particularly in a stressed market. Moreover, these banks provide the economy with less liquidity, especially in terms of their off-balance-sheet activities. We also find that banks with many partners are less likely to originate small business loans and jumbo/retained mortgages that are more sensitive to liquidity shocks. Further evidence highlights that more-partnered banks tend to have lower LCRs than do less-partnered banks, suggesting that the loose liquidity risk management of these banks drives the aforementioned adverse consequences in stressed markets.

Our results are consistent with the expectations from the extant theoretical studies on financial integration and liquidity crisis (e.g., Castiglionesi et al., 2019). Financial integration improves social welfare by allowing the risk-taking of banks in the system. Nevertheless, the integrated financial market is vulnerable to an exogenous liquidity shock, as evidenced by the financial crisis. At the onset of a liquidity shock, banks may face a high funding cost, which can impede their ordinary business, including business loan and mortgage originations. Thus, storing liquidity may ultimately help banks prevent such cases even if these banks have the capability to purchase their liquidity from their partnered institutions. The finding of this paper provides one piece of evidence that justifies the strengthened liquidity requirements for banks, such as the LCR.

Appendix A. Definition of variables

Variable	Definition	Level
DepositRate	Deposit interest rates for CDs with account size of 10,000 USD and a 12-month maturity (percent)	Bank-Month
LiquidityCreation	Berger and Bouwman's (2009) preferred liquidity creation measure relative to total assets. This "cat fat" measure classifies loans by category regardless of their maturity, whereas all other activities are classified based on both their category and their maturity. This measure also includes off-balance-sheet activities	Bank-Quarter
Log(SmallBusinesslending)	Logarithm of the aggregated amount (thousands USD) of small business lending origination by a bank in each year	Bank-Year
Log(Mortgage)	Logarithm of the aggregated amount (thousands USD) of mortgage origination by a bank in each year	Bank-Year
LCR	Ratio of a bank's high-quality liquid assets over the bank's expected net cash outflows. This ratio is estimated by using the bank's financial statements	Bank-Quarter
Log(NumPartnerships)	Logarithm of the aggregated number of business partnerships between a bank's parent BHC and syndicated loan participating financial institutions, formed by the BHC's syndicated loan arrangements during the five years before the end of the same quarter (or the end of June) of the previous year	BHC-Time (Quarter/Year)
Stress (StressQ, StressY)	Dummy variable that identifies a month (quarter, year) of market stress that is within the top 20%, measured by the monthly (quarterly, annual) average spread between yields on CPs and Treasury bills	Month/Quarter/Year
Spread (SpreadQ, SpreadY)	Monthly (quarterly, annual) average spread between the yield on CPs and Treasury bills	Month/Quarter/Year
Log(BHCAsset)	Logarithm of the parent BHC's consolidated assets (thousands USD)	BHC-Time (Quarter/Year)
Log(NumSyndicates)	Logarithm of the aggregated number of syndicated loan deals arranged by the bank's parent BHC during the five years before the end of the same quarter (or end of June) of the previous year	BHC-Time (Quarter/Year)
Log(AmtSyndicates)	Logarithm of the aggregated amount (USD) of syndicated loan deals arranged by the bank's parent BHC during the five years before the end of the same quarter (or end of June) of the previous year	BHC-Time (Quarter/Year)
Log(BankAsset)	Logarithm of a bank's total assets (thousands USD)	Bank-Time (Quarter/Year)
Loan/Asset	Ratio of a bank's total loans over the bank's total assets	Bank-Time (Quarter/Year)
Deposit/Liab	Ratio of a bank's total deposits over the bank's total liabilities	Bank-Time (Quarter/Year)
LeverageRatio	Ratio of a bank's Tier 1 capital over the bank's total assets	Bank-Time (Quarter/Year)
CapitalRatio	Ratio of a bank's regulatory capital (the sum of Tier 1 and Tier 2 capital) over the bank's total risk-weighted assets	Bank-Time (Quarter/Year)
NPLRatio	Ratio of a bank's non-performing loans over the total loans	Bank-Time (Quarter/Year)
MarketShare	A bank's deposit market share in the county in which it collects at least 65% of its deposits	Bank-Time (Quarter/Year)
C&I/Loan	Ratio of a bank's commercial and industrial loans over the total assets	Bank-Time (Quarter/Year)
Z-score	A bank's Z-score [= (LeverageRatio + ROA)/S.D.(ROA)]	Bank-Time (Quarter/Year)
HighLCR	Dummy variable that equals 1 if the annual average of a bank's quarterly LCRs during past four quarters until the previous quarter-end belongs to the top 25%, and 0 if the value belongs to the bottom 25%	Bank-Time (Quarter/Year)

Appendix B. Liquidity coverage ratio

An LCR refers to the stock of HQLAs held by a bank proportional to its expected net cash outflows over the next 30 days, where net cash outflows are cash outflows less cash inflows. This appendix provides a description of the construction of the LCR based on the publicly available information on banks' financial statements. The corresponding items from the Call Reports are in parentheses.

HQLAs are composed of two types of assets: Level 1 and Level 2. Level 1 assets include cash and balances due from depository institutions (*RCON0010*), held-to-maturity securities with 0% risk weights (*RCONB604*), available-for-sale securities with 0% risk weights (*RCONB609*), and federal funds sold and securities purchased under agreements to resell with 0% risk weights (*RCONB613* in 2001 and *RCONC063* from 2002 to 2014). Level 2 assets are subdivided into Level 2A and Level 2B assets. Level 2B assets, however, are not separately available in the public data. Level 2A assets include held-to-maturity securities with 20% risk weights (*RCONB605*), available-for-sale securities with 20% risk weights (*RCONB610*), and federal funds sold and securities purchased under agreements to resell with 20% risk weights (*RCONB614* in 2001 and *RCONC064* from 2002 to 2014). The Basel Committee on Banking Supervision (BCBS) states that qualifying corporate bonds with AA- or higher ratings are included in Level 2A assets, but they are omitted from our calculation because there was no categorization with ratings in our sample period. The stock of HQLAs is calculated as the sum of Level 1 and Level 2 assets. Level 2 assets, however, cannot exceed 40% of the total HQLAs. In other words, Level 2 assets are limited to two-thirds of Level 1 assets. In addition, a reduction of 15% is applied to the value of Level 2 assets, while the value of Level 1 assets is accepted without modification.

The calculation of expected cash flows requires several assumptions to be made, given the lack of data availability. First, the Call Reports in our sample period do not distinguish between retail deposits from individual customers and wholesale deposits from business or corporate customers. We consider deposits of less than 100,000 USD to be retail deposits and deposits of more than 100,000 USD to be wholesale deposits. If the deposit size is unavailable, we assume that the sizes of retail deposits and wholesale deposits are 50% in each category. Second, the reports do not specify whether deposits are stable in the sense that they are covered by deposit insurance or less stable. We obtain the uninsured ratio (*Uninsured*), which is the proportion of uninsured deposits (*RCON5597*) to the total deposits (*RCON2200*). Then, we assume that the proportion of less-stable deposits in each type of deposit is the same for all categories. Third, the reports do not provide the exact amount of deposits that have a maturity of 30 days or less. We assume that maturity is evenly distributed. For example, deposits of 30 days or less are approximated as one-third of deposits of three months or less.

For demand deposits and term deposits with a maturity of less than 30 days, we rely on the total transaction deposits of individuals, partnerships, and corporations (*RCONB549*) and one-third of the time deposits with a remaining maturity of three months or less (*RCONA579* for less than 100,000 USD and *RCONA584* for more than 100,000 USD). Then, we multiply the corresponding run-off ratio specified by the BCBS. For example, stable retail demand deposits and term deposits with a maturity of less than 30 days have a run-off ratio of 3%. Thus, this is calculated as $0.03 \times [(1\text{-}Uninsured) \times 0.5 \times RCONB549 + (1\text{-}Uninsured) \times 1/3 \times RCONA579]$. Wholesale funds from non-financial corporations, sovereigns, central banks, multilateral development banks, and public sector entities are calculated as the sum of the total transaction deposits of the U.S. government (*RCON2202*), the total transaction deposits of states and political subdivisions in the United States (*RCON2203*), and the total transaction deposits of foreign governments and official institutions (*RCON2216*). Similarly, wholesale funds from other legal entity customers are estimated as the sum of the total transaction deposits of commercial banks and other depository institutions in the United States (*RCONB551*), the total transaction deposits of banks in foreign countries (*RCON2213*), and one-twelfth of the other borrowings with a remaining maturity of one year or less (*RCONB571*).

Expected cash outflows include not only on-balance-sheet items but also off-balance-sheet items, particularly undrawn committed credit and liquidity facilities. To calculate expected cash outflows, we include the unused commitments secured by family residential properties (*RCON3814*); unused credit card lines (*RCON3815*); unused commitment to commercial real estate, construction, and land development (*RCON3816*); unused commitments to securities firms (*RCON3817*); and other unused commitments (*RCON3818*). In addition, we consider various letters of credit, including financial standby letters of credit (*RCON3819*), performance standby letters of credit (*RCON3821*), and commercial letters of credit (*RCON3411*). All of these items are multiplied by the corresponding run-off rates proposed by the BCBS.

Finally, cash inflows comprise maturing loans and securities. For example, expected cash inflows include one-third of the closed-end loans secured by family residential properties with a maturity of less than three months (*RCONA564*) and one-third of the securities issued by the U.S. government, states and political subdivisions, and mortgage pass-through securities not backed by family residential properties with a maturity of less than three months (*RCONA549*). We obtain each bank's LCR from HQLAs divided by the difference between cash outflows and inflows.

CRediT authorship contribution statement

Seungho Choi: Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Yong Kyu Gam:** Project administration, Conceptualization, Methodology, Software, Investigation, Writing - original draft, Writing - review & editing. **Junho Park:** Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Hojong Shin:** Project administration, Conceptualization, Methodology, Validation, Writing - original draft, Writing - review & editing.

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