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Gounopoulos, Dimitrios and Luo, Kaisheng and Nicolae, Anamaria and Paltalidis, Nikos

University of Bath School of Management, Durham University Business School, Durham University Business School, Durham University Business School

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Dimitrios Gounopoulos
University of Bath School of Management

Kaisheng Luo
Durham University Business School

Anamaria Nicolae
Durham University Business School

Nikos Paltalidis
Durham University Business School

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Abstract

How banks managed the COVID-19 pandemic shock? The eruption of the financial crisis in 2007 evolved to a crisis of banks as liquidity providers (Acharya and Mora, 2015). The COVID-19 pandemic shock was associated with a surge in households' deposits and a subsequent liquidity injection by the Federal Reserve. We show how the pandemic affected banks' liquidity management and therefore by extension, the creation of new loans. We empirically evaluate the creation and management of banks' liquidity through three well established mechanisms: market discipline (supply-side), internal capital markets (demand-side), and the balance-sheet mechanism which captures banks' exposure to liquidity demand risk. We provide novel empirical evidence showing that households increased savings as a precaution against future declines in their income. Also, depositors did not discipline riskier banks, and the internal capital market mechanism was not in work during the pandemic. Hence, weakly-capitalized banks were not forced to offer higher deposit rates to stem deposit outflows. Furthermore, weakly-capitalized banks increased lending in the first phase of the pandemic, while in the midst of the pandemic, they cut back new lending origination and increased their exposure to Fed's liquidity facilities. Well-capitalized banks on the other hand, increased lending in line with the increase in their deposits. Banks with higher exposure to liquidity risk were vulnerable to deposit outflows and increased their exposure in Fed's liquidity facilities significantly more than low-commitments exposed banks.

JEL classification: E51; E58; G21; G20

Keywords: Financial Institutions; Liquidity Risk; Bank Lending; COVID-19; Monetary Policy

*Dimitrios Gounopoulos is from University of Bath School of Management, University of Bath, U.K., e-mail: dimitrios.gounopoulos@bath.ac.uk; Kaisheng Luo is from Durham University Business School, Durham University, U.K., e-mail: kaisheng.luo@durham.ac.uk; Anamaria Nicolae is from Durham University Business School, Durham University, U.K., e-mail: anamaria.nicolae@durham.ac.uk; Nikos Paltalidis is from Durham University Business School, Durham University, U.K., e-mail: nikos.e.paltalidis@durham.ac.uk.

1. Introduction

In December 2019, a novel coronavirus was detected in Wuhan, China and spread worldwide within less than three months causing a global health crisis. To contain the COVID-19 virus, governments launched unprecedented measures, including partial (work-from-home policies) or even full shutdown of businesses and economic activities. In the United States the COVID-19 pandemic triggered a severe economic downturn of uncertain duration. At the first phase of the pandemic-induced crisis firms drew heavily on credit lines. As a result, banks faced unprecedented credit line drawdowns which caused a dramatic spike in loan growth and stressed their liquidity. As a response, the Federal Reserve introduced liquidity schemes to facilitate financial institutions in distress condition. In the 2007 Global Financial Crisis, increased takedown demand for unused credit lines displaced lending capacity, and consequently banks exposed to liquidity risk adjusted their credit exposures and did not honor their credit commitments to firms (Ivashina 2009; Cornett et al. 2011; Acharya and Mora, 2015).

In this paper, we investigate how the COVID-19 pandemic shock affected banks' liquidity management and consequently, the supply of new loans? More specifically, we investigate how banks adjusted their lending, their deposit rates, and their exposure to Federal Reserve's liquidity facilities in response to the pandemic. We investigate these questions by studying both the supply and the demand side of banks' liquidity creation through three mechanism: i. the market-discipline theory (supply-side); ii. the internal capital markets theory (demand-side); and iii. the balance sheet channel, which captures banks' exposure to liquidity demand risk.

The supply determinant of banks' liquidity management investigates how banks' depositors reacted during the pandemic. Deposits are a critical source of funding for banks since an increase (decrease) in deposit rates reflects a rise (drop) in banks' cost-of-credit. As

figure 1 shows, households increased bank deposits for the whole period of 2020, with most notable the dramatic increase that took place in the first phase of the pandemic (quarter 1, 2020). Theory suggests that households increase bank savings either as a precaution against uncertainty in future income ("precautionary savings" theory, Browning and Lusardi, 1996), or as a shift to safer investments ("flight to safety" theory, Bernanke, Gertler, and Gilchrist, 1996). We show that the increase in deposits is a result of precautionary savings since households increased the inflow of deposits for both risky and safe banks. Furthermore, we find that in states with higher COVID-19 cases, banks experienced a significantly higher increase in deposit amount, and they offered significantly lower deposits rates than in states with lower COVID-19 cases. These results support the suggestion that households increased savings as a precaution against uncertainty in future income.

Financial intermediation theory suggests that depositors exercise market discipline by demanding higher deposit rates from weakly capitalized (hence, riskier) banks (e.g., see Diamond and Rajan, 2000). We use branch-level data of deposit rates in Certificate of Deposits (CDs) of U.S. banks from 2016 (pre-pandemic era) till the end of 2020 (pandemic era) to identify whether riskier banks offered higher rates to depositors. To effectively investigate the hypothesis, we test for both insured ($10,000 and $100,000) and uninsured CDs with amounts higher than $250.000, and we measure banks' riskiness based on their equity-to-assets ratio in line with the literature (e.g., see Ben-David, Palvia, and Spatt, 2017; and Brown and Dinc, 2017). If flight to safety and market discipline are exercised by depositors, then deposit rates should be higher for weakly capitalized (i.e., riskier) banks. We find that the coefficient on the equity-to-assets ratio is not negative implying that deposit rates are actually lower on average for weakly capitalized banks during the pandemic. This result indicates the absence of market discipline and provides further support to our suggestion that households increase savings as a

precaution against uncertainty in future income. Our results remain similar across different deposit sizes.

Next, we investigate the demand determinant for deposits which suggests that banks adjust deposit rates based on their internal funding needs, that is the triple interaction between deposit growth, deposit rates and lending growth. Concretely, this mechanism suggests that banks use deposits as an internal capital market, that is they increase deposit rates based on their internal funding needs, such as to attract new deposits in order to originate new loans. Theory suggests that during distress conditions, banks have a sui generis advantage of using deposit inflows to fund their liabilities or to grant new loans (see for example Diamond and Dybvig 1983, and Diamond 1984). To tackle endogeneity concerns, we test the relation between bank-level deposit rates and loan growth based on the state-level loan growth. This approach has also been implemented by Ben-David, Palvia, and Spatt (2017), and one of its advantages is that it is based on market-level lending activity rather than on the bank's endogenous lending decisions. We measure state-level loan growth as the median loan growth of single-state banks for states in which the bank operates.

Our expectation is to find a positive relationship between bank-level deposit rates and loan growth during stressful financial conditions, if the hypothesis holds and banks determine deposit rates based on their funding needs. We find that before the pandemic, an increase in the flow of deposits is positively related with both loan growth and deposit rates. Although this result is consistent with the internal capital market theory which suggests that banks offer higher deposit rates to attract more deposits, during the COVID-19 pandemic this relationship changes. Precisely, deposit flows are positively correlated with loan growth, but *negatively* correlated with deposit rates, which indicates that the internal capital market was not in work during the pandemic. The results remain similar across different categories of loans, such as for Net Loans and Leases, and for Commercial and Industrial (C&I) loans.

The third mechanism through which banks create and manage their liquidity is the off-balance-sheet unused credit commitments that can be converted to loans and therefore, represent liquidity risk for banks. In addition, we employ banks' exposure in wholesale funding that represents short-term liquidity commitments. In line with Acharya and Mora (2015), and Acharya, Engle and Steffen (2021), we define liquidity demand risk as banks' undrawn lending commitments and wholesale funding that exceed their deposits. We find that commitments-exposed banks with a liquidity shortage during the pandemic offered higher deposit rates to axe deposit outflows. Further, we document that banks with high liquidity risk increased their exposure in Fed's liquidity facilities significantly more than banks exposed to low liquidity risk. We also test whether banks responded to the liquidity shock by cutting back new credit to meet increased loan commitment. The results reveal that banks with high exposure in credit commitments reduced the provision of new loans and leases. In contrast, banks with low credit commitments increased the supply of new loans and leases to firms.

Our paper contributes in four ways in the empirical literature that investigates how banks manage their liquidity and adjust their lending during crisis episodes. First, our work shows that during the COVID-19 crisis a precautionary savings effect is in work: in states with high COVID-19 cases deposit amounts increase significantly more and deposit rates decrease significantly more than in banks exposed to states with low COVID-19 cases. In a recent work, Hasan, Politsidis, and Sharma (forthcoming) find that syndicated loan spreads rise for lenders with exposure to COVID-19, a result which supports our suggestion that households increased deposits as a precaution to future declines in income caused by the COVID-19 shock. Second, we show that banks with high liquidity risk honored their credit commitments by adjusting their lending, in contrast to the 2007 Global Financial Crisis (Ivashina 2009; Cornett et al. 2011; Acharya and Mora, 2015). We also find that banks with low liquidity risk expanded the supply of commercial and industrial loans during the COVID-19 crisis. In a similar vein, Li, Strahan

and Zhang (2020), show that banks were able to accommodate liquidity demands during the first quarter of the COVID-19 pandemic shock.

Third, we also contribute on the literature that investigates whether depositors exercise market discipline. Calomiris and Kahn (1991) and Calomiris (1999) advocate the market discipline theory as a regulatory tool where depositors are concerned about the safety of their deposits, and hence they demand a higher rate from riskier banks. Park and Peristiani (1998), Peria and Schmukler (2001), Hett and Schmidt (2017) provide empirical evidence that riskier institutions provide higher deposit rates. In contrast, Ben-David, Palvia, and Spatt (2017) find that deposit rates in the US during the financial crisis of 2008 were determined by internal capital markets rather than by market discipline. In a similar vein, we document the absence of market discipline during the COVID-19 pandemic.

Furthermore, we contribute on the literature that investigates banks' liquidity creation through their internal capital markets, which argues that banks create liquidity on the balance sheet by financing illiquid assets with liquid liabilities (Diamond and Rajan, 2000). Therefore, banks' internal demand for funding prompts a rise in their deposit rates in order to increase the flow of deposits. As a result, loan growth and deposit growth are strongly correlated. Ben-David, Palvia, and Spatt (2017) provide empirical support that this mechanism was in work during the 2008 financial crisis for banks. We document that during the COVID-19 pandemic the internal capital market was not in work. However, we also find that banks generated liquidity even though they lowered their deposit rates, a result which indicates that the injection of liquidity from the Federal Reserve alleviated the effect of the pandemic in banks' liquidity risk.

The rest of the paper is organized as follows. Section 2 presents a summary of the related literature. Section 3 describes the dataset and the econometric procedure used in the

study. Section 4 presents and discusses the main empirical results. Section 5 provides additional tests for the robustness of our findings. Finally, section 6 concludes.

2. Literature Review

According to the financial intermediation theory, a fundamental feature of banks is the creation of liquidity and the subsequent transformation of risk, jointly referred to as banks' qualitative asset transformation (QAT) function (Bhattacharya and Thakor, 1993). Banks' risk transformation refers to the issuance of riskless deposits to finance risky loans. This theory argue that banks create liquidity when they issue riskless deposits to fund illiquid loans (Diamond 1984; Ramakrishnan and Thakor 1984; Boyd and Prescott 1986). Banks have two ways to create and manage liquidity through deposits: i. by rising rates to stem deposit outflows or to increase inflows, that is the supply of deposits by households (the market discipline channel); and ii. by rising rates to attract new deposits with the intention to increase their lending, that is the demand for deposits by banks (the internal capital markets channel). Banks' exposure to risky loans is associated with a third channel of liquidity pressure, the so-called liquidity demand risk (Acharya and Mora 2015). Unused credit lines are commitments that banks have to honor and especially during stressful conditions, corporations drawdown these loans to mitigate liquidity problems. Below we provide more analysis and develop our hypotheses.

2.1.1 Market discipline

More concretely, the financial intermediation theory suggests that during crises episodes, depositors are concerned about the safety of their deposits. Therefore, they punish riskier banks by requiring a higher rate, giving rise to the market discipline theory. In the empirical literature, Gorton (1988), Saunders and Wilson (1996), and Calomiris and Mason

(1997), document that banks with worse fundamentals experience greater deposit outflows in a crisis. Calomiris and Kahn (1991), and Calomiris (1999) argue that, the market discipline theory operates as a regulatory tool where depositors demand a higher rate or withdraw their deposits as a form of discipline on risky banks. Park and Peristiani (1998), Peria and Schmukler (2001), and Hett and Schmidt (2017) provide empirical evidence that riskier institutions provide higher deposit rates. Also, the empirical literature in market discipline finds that larger banks experience higher deposit growth in a crisis (Martinez-Peria and Schmukler (2001), and that larger banks suffer fewer withdrawals than smaller ones (Billett, Garfinkel, and O'Neal, 1998; Goldberg and Hudgins, 2002).

In a similar vein, we test the market discipline hypothesis, that depositors require from riskier banks a higher premium for their deposits during a crisis, and in return riskier banks offer to pay higher deposit rates to stem deposit outflows during the COVID-19 pandemic. Theory suggests that higher capital improves banks' ability to absorb risk and hence their ability to create liquidity. Therefore, for riskier banks (i.e., weakly-capitalized banks) the relation between deposit rates and the equity-to-assets ratio should be negative. Building on this hypothesis, we suggest that the injection of liquidity from the Federal Reserve during the COVID-19 pandemic, indirectly recapitalized riskier banks through its positive impact on banks' liquidity and consequently it helped to avoid the exercise of market discipline.

2.1.2 The internal capital markets mechanism

Another way through which banks create and manage liquidity is the internal capital market. This mechanism is in work when banks increase deposit rates with the aim of boosting their deposits to fund new loans. Houston, James, and Markus (1997), Campello (2002) and Aschraft and Campello (2007) show that loans increase and decrease with the level of deposits providing empirical support for the importance role of the internal capital market in the creation

and management of liquidity. Banks can respond to a funding shock by reallocating funds across locations through their internal capital markets. For the internal funding reallocation dynamics, Cetorelli and Goldberg (2012a), (2012b) provide direct evidence for the existence of a cross-border capital market where international banks transfer deposits across different regions to support new lending opportunities or to overcome liquidity shocks. A notable contribution in the literature is the work of Ben-David, Palvia, and Spatt (2017) which shows that deposit rates are mainly driven by banks' incentives for new loans rather than to stem deposits outflow.

Similarly, we test the internal capital markets theory hypothesis which suggests that banks determine deposit rates based on their funding needs. Precisely, banks' incentives to provide new loans drives deposit rates higher and by extension deposits grow. Then, the increase in deposits is used to fund new loans. Therefore, our second hypothesis suggests that the relationship between deposit growth, lending growth and deposit rates should be positive. Since, the results show that this mechanism was not in work during the pandemic, we test an additional hypothesis which suggests that the introduction of ample liquidity by the Federal Reserve during the COVID-19 pandemic helped banks to improve their liquidity levels. Therefore, banks achieved to increase their deposits, to provide new loans, while lowering their cost of capital -i.e., their deposit rates-.

2.1.3 Balance-sheet liquidity mechanism

Another important source through which banks create and manage their liquidity stems from exposure to undrawn loan commitments and exposure in wholesale funding. Unused loan commitments are the parts of credit lines that have not been drawn down, but banks are supposed to honor their obligation to fund these loans when requested by firms. Therefore, theory suggests that banks also create and manage their liquidity off the balance sheet through

loan commitments (Diamond and Dybvig, 1983; Holstrom and Tirole, 1998; Kashyap, Rajan, and Stein, 2002). During periods of crisis, government interventions can help to prevent deposit outflows from banks, as showed in Gatev and Strahan (2006). However, another source of concern is that the higher the exposure to unused loan commitments the higher the liquidity risk and the liquidity needs for banks.

In addition, banks' exposure in wholesale funding represents short-term liquidity commitments. In line with Acharya and Mora (2015), and Acharya, Engle and Steffen (2021), we define liquidity demand risk as the ratio of banks' undrawn lending commitments and wholesale funding that exceed their deposits divided by banks' assets. The higher the exposure to unused credit commitments, the higher the liquidity risk for banks. In the empirical literature, Acharya and Mora (2015) report that during the 2007 financial crisis, deposit inflows into banks weakened and banks' loan-to-deposit shortfalls widened. As a result, banks with high exposure to unused credit commitments failed to meet their obligations. Also, the rest of the banks honored credit lines to firms because of the liquidity programs introduced by the government-sponsored agencies. Ivashina and Scharfstein (2010) study the 2007 crisis and show that more vulnerable banks with the higher credit line drawdowns adjusted their credit by cutting new lending. In a similar vein, Cornett, McNutt, Strahan, and Tehranian (2011) document that liquidity shocks led to a decline in credit supply during the financial crisis of 2007. Banks with strong capitalization continued to lend compared to relative poorly capitalized banks. However, banks with high off-balance-sheet liquidity risk significantly constrained new lending origination.

Holstrom and Tirole (1998) and Kashyap, Rajan, and Stein (2002) suggest that banks can also face liquidity risk through off-balance-sheet unused loan commitments. Acharya and Mora (2015) provide empirical evidence that during the 2007 crisis, banks' with high exposure in undrawn lending commitments failed to meet their credit commitments.

We also test whether commitments-exposed banks experience high liquidity needs to honor their credit commitments, and therefore they offer to pay higher deposit rates to stem deposit outflows. Based on that hypothesis, banks with high liquidity risk adjust their credit lines by cutting new lending. Our fourth hypothesis suggests that banks with high liquidity risk increased their exposure to liquidity facilities offered from the Federal Reserve significantly more than banks with low commitments. This in turn, indirectly recapitalized banks, and helped banks to improve their liquidity, to honor their credit commitments, and to avoid an increase in their deposit rates.

3. Data and methodology

3.1 Data

In this section we provide a brief description of the dataset used in this study. We use several sources of data from January 2016 till December 2020 in a quarterly frequency:

- **Deposit rates**: We use deposit rates provided by RateWatch in branch level of US banks (money market deposits as well as Certificate of Deposits data). We use 3 kinds of deposit products across all U.S. branches: 12-month Certificates of Deposit with an account size up to $10,000; 12-month Certificates of Deposit (CDs) with an account size up to $100,000; and 12-month Certificates of Deposit (CDs) with an account size up to $500,000. The data is available in a monthly frequency.
- **Bank loans:** We collect detailed information on syndicated bank loans from Thomson Reuter's Dealscan. This source reports each loan as a deal, and contains information on the amount, the rate, the maturity, the lenders' and the borrowers' names.
- **Banks' financial condition:** We use the Reports of Condition and Income (also known as Call Reports) to collect information to measure banks' capitalization, liquidity, commercial

and industrial loans growth, net loans and leases growth, deposits, asset size, unused credit commitments, and wholesale funding.

- **COVID-19 Cases:** We collect detailed information for the number of cases per capita per state in the U.S. by using the rich dataset of CDC COVID Data Tracker.

3.2 Methodology

In this section we present the methodology used to test our hypotheses. We begin with the investigation of the market discipline mechanism and the precautionary savings hypothesis, followed by next we present the empirical model for the internal capital market hypothesis and we conclude with the test for the effect of liquidity risk in the deposit rates, the flow of deposits, the supply of credit and on the use of Fed's liquidity facilities.

3.2.1 Market Discipline Theory and Precautionary Savings

If market discipline is exercised, then during distress conditions, depositors are concerned about their deposits and therefore they discipline riskier banks by demanding higher rates. In line with the literature, we employ the equity-to-assets ratio as a proxy to identify which banks are riskier (e.g., see Diamond and Rajan, 2000; Brown and Dinc, 2011; Ben-David, Palvia, and Spatt 2017 *inter alia*).

$$Deposit\_Rate_{i,q} = \alpha + \beta_1 EA_{i,q-n} \times I(q < 2020) + \beta_2 EA_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (1)$$

where $Deposit\_Rate_{i,q}$ is defined as the deposit rate of bank i at quarter q. $EA_{i,q-n}$ represents the lagged equity-to-assets ratio, with the number of lags being $n = \{1, 2\}$. $I(q < 2020)$ and $I(q \geq 2020)$ denote whether quarter q precedes 2020. $B_{i,q-1}$ is a set of bank-quarter control variables. T_q represents a set of quarter fixed effects. All specifications are estimated with robust standard errors clustered by bank and quarter. We regress deposit rates of the same

duration (12 months) but across different amounts of Certificates of Deposits ($10,000 and $500,000, and for $100,000 as a robustness test). If market discipline is exercised, the sign of the coefficient on the equity-to-assets ratio should be negative for weakly-capitalized banks.

Furthermore, to test for the precautionary savings theory we suggest that in counties with the higher COVID-19 cases banks' deposits grow faster and deposit rates decrease significantly more than in counties with low COVID-19 cases.

$$Deposit\_Rate_{i,q} = \alpha + \beta_1 COVID-19\ Cases_{c,q} + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (2)$$

where, $COVID-19\ Cases$ represents COVID-19 cases in county i at quarter q.

And accordingly, for deposits:

$$Deposit\_Growth_{i,q} = \alpha + \beta_1 COVID-19\ Cases_{c,q} + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (3)$$

3.2.2 Internal Capital Markets

If the internal capital market mechanism is at work, banks' incentive to provide new loans lead to an increase in deposit rates, which in turn results to a rise in deposits. The increase in liquidity is used to fund the provision of new loans. Therefore, in Equation (4) below, if banks use their internal capital markets to create liquidity, there should be a positive coefficient on loan growth (i.e. β_2) and on the deposit rate (i.e. β_4).

$$Deposit\_Growth_{i,q} = a + \beta_1 Loan\_Growth_{i,q-n} + \beta_2 Loan\_Growth_{i,q-n} \times I(q \geq 2020) + \beta_3 Deposit\_Rate_{i,q-n} + \beta_4 Deposit\_Rate_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (4)$$

where $Deposit\_Growth_{i,q}$ represents the quarter-on-quarter net growth in total deposits for bank i. $Loan\_Growth_{i,q-n}$ is lagged quarter-on-quarter growth in Net Loans and Leases for bank i. The number of lags is $n = \{1, 2\}$. $Deposit\_Rate_{i,q-n}$ represents the lagged quarter-on-quarter deposit rate of bank i at quarter $q - n$. All specifications are estimated with robust standard errors clustered by bank and quarter. Similar to Equation (1), we regress deposit rates

of the same duration (12 months) but across different amounts of Certificates of Deposits ($10,000 and $500,000).

Since the internal capital markets mechanism suggests that loan growth determines deposit rates, we also test the relation between the two instruments before and during the pandemic. If our hypothesis holds, then the coefficient of loan growth (i.e., β_1 and β_2) in Equation (5) should be positive.

$$Deposit\_Rate_{i,q} = \alpha + \beta_1 State\_Level\_Loan\_Growth_{i,q-n} + \beta_2 State\_Level\_Loan\_Growth_{i,q-n} \times I(q \geq 2020)\gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (5)$$

where $Deposit\_Rate_{i,q}$ represents the quarter-on-quarter deposit rate of 12-month maturity and $500,000 for bank i. Similar to Ben-David, Palvia, and Spatt (2017), to easy endogeneity concerns, we measure state-level loan growth to test its relation with bank-level deposit rates $State\_Level\_Loan\_Growth_{i,q-n}$ is lagged quarter-on-quarter growth across different categories of loans: Commercial & Industrial (C&I) and Net Loans and Leases for bank i. The number of lags is $n = \{1, 2\}$. All specifications are estimated with robust standard errors clustered by bank and quarter.

Furthermore, we assess the relation between deposit growth and loan growth, since our internal capital markets hypothesis suggests that banks' incentives to provide new loans leads to a haunt to increase their core deposits. To test the first part of the hypothesis we ask: Is deposit growth positively correlated with bank lending growth? Empirically, we follow the approach of Jayaratne and Morgan (2000).

$$Deposit\_Growth_{i,q} = a + \beta_1 Loan\_Growth_{i,q-n} + \beta_2 Loan\_Growth_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (6)$$

where $Deposit\_Growth_{i,q}$ represents the quarter-on-quarter change in deposits to total assets ratio for bank i. $Loan\_Growth_{i,q-n}$ is lagged quarter-on-quarter growth across two categories of loans: Syndicated loans and Net Loans and Leases for bank i. The number of lags is $n =$

$\{1, 2\}$. All specifications are estimated with robust standard errors clustered by bank and quarter.

3.2.3 Liquidity Risk from Loan Commitments

Banks can also create liquidity off the balance sheet through unused credit commitments. These commitments are the parts of credit lines that have not been drawn down, but banks are supposed to honor their obligation to fund these loans when requested by firms. Therefore, the higher the exposure to unused credit commitments, the higher the liquidity needs and hence, the higher the liquidity risk. We follow Acharya, Engle and Steffen (2021) to measure liquidity risk, by adding wholesale funding exposure to unused credit commitments, and subtracting this with available cash in banks' balance sheets. The empirical literature suggests that during crisis episodes banks with high liquidity risk offer to pay higher deposit rates to attract more deposits. In turn these deposits will be used to honor their credit commitments. To test this hypothesis, we evaluate the relation between unused credit commitments with deposit rates, and deposit growth. If our hypothesis holds, then the sign of the coefficient on liquidity risk should be positive, and negative on deposit growth.

$$Liquidity\ Risk = \frac{Unused\ Commitmetns + Wholesale\ Funding - Cash}{Total\ Assets} \quad (7)$$

$$Deposit\_Rates_{i,q} = a + \beta_1 Liquidity\_Risk_{i,q-n} + \beta_2 Liquidity\_Risk_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (8)$$

and for the relation with deposits:

$$Deposit\_Growth_{i,q} = a + \beta_1 Liquidity\_Risk_{i,q-n} + \beta_2 Liquidity\_Risk_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (9)$$

Furthermore, we assess whether banks with high liquidity risk adjust their credit by cutting new lending during the pandemic. To test this hypothesis, we use three different

categories of lending: Syndicated loans, Commercial and Industrial Loans, and Net Loans and Leases:

$$Loan\_Growth_{i,q} = a + \beta_1 Liquidity\_Risk_{i,q-n} + \beta_2 Liquidity\_Risk_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (11)$$

Finally, we assess whether banks exposed to higher liquidity risk increased their exposure to liquidity facilities introduced by the Federal Reserve during the COVID-19 pandemic. Our hypothesis is that vulnerable banks with exposure to high liquidity risk increased their exposure to facilities offered by the Federal Reserve to improve their liquidity levels:

$$Liquidity\_Risk_{i,q} = a + \beta_1 FED\_Liquidity_{i,q-n} + \beta_2 FED\_Liquidity_{i,q-n} \times I(q \geq 2020) + \gamma B_{i,q-1} + \delta T_q + \varepsilon_{i,q} \quad (12)$$

where $FED\_Liquidity_{i,q-n}$ is the lagged quarter-on-quarter change on the sum of Total Federal Funds sold to Commercial Banks, Reverse Repurchases, Vault Cash and Cash Items, and Balances due from Federal Reserve Banks for each bank i.[1]

4. Empirical results

In this section we present the results of the empirical tests for the effect of the pandemic and the effectiveness of the liquidity programs implemented by the Federal Reserve in banks' management of liquidity and credit commitments. Table 1 presents summary statistics for the main variables.

-Please Insert Table 1 here-

[1] Total Federal Funds sold to Commercial Banks and Reverse Repurchases and Vault Cash and Cash Items and Balances due from Federal Reserve Banks are available from the Board of Governors of the Federal Reserve System, account H8 "Assets and Liabilities of Commercial Banks in the United States", and can be found here.

4.1 Precautionary Savings and Market Discipline

We start by investigating how the pandemic affected depositors' behavior. Table 2 shows that higher COVID-19 cases are associated with a significant decrease in deposit rates decrease and significant growth in deposit amounts. These results support the suggestion that households increase savings as a precaution against declines in future income. Next, we test whether depositors exercise market discipline during the pandemic-induced crisis by demanding a higher premium from risky banks. If weakly capitalized banks offer higher deposit rates to stem deposit outflow, the coefficient on the equity to assets ratio will be negative, and market discipline is exercised. On the other hand, if the injection of liquidity from the Federal Reserve is effective, then depositors will not request higher rates from weakly-capitalized banks, and hence, the coefficient on the equity to assets ratio will be positive. In Table 3 we present the results obtained from regressing deposit rates for different amounts ($10k and $500k Certificate of Deposits) on the equity to assets ratio. Deposits in the United States above $250k are not insured by the FDIC and therefore these deposits should, at least in theory, be more sensitive during crisis episodes. Panel A of Table 3 presents results for the period before and during the pandemic for the overall sample of banks. The results show that all coefficients are positive and statistically significant at 1% before and during the pandemic, indicating that market discipline was not exercised by depositors.

Next, we construct a subsample of weakly-capitalized banks to further investigate the market discipline hypothesis. Weakly capitalized banks are defined as the bottom 10% of capitalization within each quarter. If market discipline is exercised, the sign of the coefficient on capitalization should be negative for risky banks. Panel B shows that this coefficient is positive and statistically significant for deposits of $10k, while the coefficient for deposits of $500k is not significant. Therefore, we argue that risky banks do not offer higher deposit rates to stem deposit outflows. If market discipline was a salient factor, we should observe a

significant negative relation between deposit rates and weakly-capitalized banks. Furthermore, these results support the findings presented in Panel A which show that market discipline was not exercised for the overall sample of banks. In contrast, the results indicate that the injection of liquidity from the Federal Reserve alleviated the concerns of liquidity stress and strengthened the liquidity condition of weakly capitalized banks. Since deposits are a critical source of funding for banks, this result also implies that banks lowered their cost of credit. In the robustness tests section, we provide additional robustness analyses which show the weak relationship between deposit rates and the capital ratio for deposits of different account size.

-Please Insert Table 2 here-

-Please Insert Table 3 here-

4.2 The Internal Capital Market Channel

In this section we test whether the pandemic affected the demand side for deposits, that is the internal capital market through which banks create liquidity. The market discipline hypothesis suggests that deposit rates mirror bank risk, since weakly-capitalized banks should offer higher deposit rates. However, depositors might favor banks that offer lower deposit rates, due to differences in risk. In contrast, the internal capital market hypothesis suggests that banks' intention to provide new loans leads to offer higher deposit rates to increase the flow of deposits and thus by extension to fund these loans. For this hypothesis to hold, deposit growth must be positively correlated with loan growth and with deposit rates.

4.2.1 The Relationship between Deposit Growth, Lending Growth, and Deposit Rates

In Table 4 we present the results from the regression estimated with standard errors clustered by bank and quarter (time). Loan growth is lagged, and it is measured by the quarterly change in net loans and leases, while deposit rates are measured through the Certificate of Deposits for accounts of $10k (Table 4). In Panel A of Table 4 we include all banks, and in

columns (1) and (2) we first test the relation between loan growth and deposit growth. The results show that before the pandemic deposit growth has a significantly opposite direction of loan growth. However, this relationship changes during the pandemic, when deposit growth is very strongly correlated with loan growth. Further, the correlation increases during the COVID-19 pandemic crisis and it is statistically significant at 1%. Precisely, column (1) in Table 4 reveals that a 1-standard-deviation change in net leases and loan growth is associated with a change of 0.5% in the same direction in deposit growth. Next, in columns (3) and (4), we include deposit rates on the right-hand side to examine the relation between lagged loan growth, lagged deposit rates and deposit growth. We find that deposit flows are positively correlated with growth in net loans and leases but *negatively* correlated with deposit rates during the pandemic. As a result, during the pandemic banks increase their deposit growth even though they offer lower deposit rates.

In Table A1 in the Appendix, we test the same regression for accounts of £500k. When we use the alternative deposit account of $500k in Panel A of Table A1, the pattern continues to hold and the relation between deposit growth, lending growth and deposit rates is the same with the one observed in Table 4. Moreover, we breakdown the sample by bank capitalization to examine the same relation in Panels B (weakly capitalized) and C (well-capitalized) of Table 4. Weakly capitalized banks are defined as the bottom 10% of capitalization within each quarter, and well-capitalized banks as the top 10% of capitalization within each quarter. The results show that deposit growth is *negatively* correlated with deposit rates and with loan growth for weakly capitalized banks. When we test the same relationship with accounts of $500k, the results hold, indicating the robustness of our findings (Table A1). Notably, at the onset of the pandemic (quarter 1), the relation between deposit growth and lending growth was *positively* correlated. These results reflect the drewdown in credit lines from firms which resulted to an increase in bank lending during the first phase of the pandemic. However, weakly-capitalized

banks adjusted their lending in the next quarters, by decreasing the provision of new loans. Finally, in Panel C of Table 4 we find that deposit growth is positively correlated with loan growth but *negatively* correlated with deposit rates for well-capitalized banks. The positive relation between deposit growth and lending growth implies that well-capitalized banks increased lending during the pandemic. Similar results are reported when we test for deposit accounts of $500k in Table A1 providing strong robustness for our findings.

-Please Insert Table 4 here-

Furthermore, we use Commercial and Industrial loans as an alternative measure of bank lending to examine the internal capital markets hypothesis. In Table 5 we present the results from the regression estimated with standard errors clustered by bank and quarter (time). Deposit rates are measured through the Certificate of Deposits for accounts of $10k. In Panel A of Table 5 we include all banks and in columns (1) and (2) we first test the relation between loan growth and deposit growth. For commercial and industrial loans, our results show a *positive* relationship in the first phase (Quarter 1) of the pandemic, and then it changes to negative afterwards. This result is consistent with the dramatic increase in involuntary lending that was caused when firms drewdown credit lines at the onset of the pandemic. In contrast, loan growth and deposit growth are always negatively correlated in the pre-pandemic period. A 1-standard-deviation change in loan growth is associated with a change of 13% in the same direction of deposit growth. Similar with the results in net loans and leases, we find that deposit growth is negatively correlated with deposit rate.

To ensure that our results are not driven by the regulatory protection that depositors enjoy for accounts less than $250k, we test the relation between deposit growth, lagged loan growth, and lagged deposit rates for Certificates of Deposits of $500k. In Table A2 in the Appendix, we report the results with the alternative deposit account of $500k., and we find that the same relations hold for both the pandemic and the pre-pandemic period. Since we do not find a positive relationship between deposit growth, deposit rates and loan growth for both loan

categories, we conclude that banks improve their liquidity without the use of their internal capital market – the supply side of liquidity creation.

Further, we breakdown the sample by bank capitalization to examine the same relation with weakly capitalized (Panel B) and well-capitalized (Panel C) banks in Table 5. For weakly capitalized banks, our results show that deposit growth is negatively correlated with loan growth, while we find weak significance for deposit rates during quarter 1 only. For well-capitalized banks the results show that there is positive relation between deposit growth and loan growth, while we do not find significance for deposit rates. These results indicate that in contrast with well-capitalized banks, less capitalized banks were forced to cut back in new credit origination as a response to the liquidity shock, while deposit rates do not play a significant role in the creation of liquidity to fund new loans. In Table A2, we test the same relationship with accounts of $500k hold, and we obtain similar results, indicating strong robustness for our findings.

-Please Insert Table 5 here-

4.2.2 The Relationship between Deposit Rates and Lending Growth

Next, we investigate the relationship between deposit rates and loan growth. In Table 6 we present the results from the regression estimated with standard errors clustered by bank and quarter (time). Loan growth is lagged, and it is measured by the quarterly change in net loans and leases. According to the internal capital market hypothesis, deposit rates should be positively correlated with loan growth. In Panel A of Table 6 we include all banks, while deposit rates are measured as Certificate of Deposits of $10k in columns (1) and (2), $100k in columns (3) and (4), and $500k in columns (5) and (6). We find that there is no strong relationship between deposit rates and loan growth, indicating that internal capital markets are not in work. We also breakdown the sample by bank capitalization in Panels B and C. For weakly-capitalized banks (Panel B) we find a negation relation for accounts of $10k., and 100k.,

however the significance is weak. Similarly, for well-capitalized banks (Panel C) the regression provides a meaningful positive coefficient between deposit rates and lending growth in quarter 3 for all account sizes in the pandemic crisis period only. This result indicates that well-capitalized banks have the ability to increase their lending by offering higher deposit rates. In contrast, for weakly-capitalized banks, deposit rates are not the dominant factor to grow their lending.

-Please Insert Table 6 here-

We examine further the relationship between deposit rates and lending growth by replacing net loans and leases with commercial and industrial loans in Table 7. To avoid any endogeneity concerns, we use banks' loan growth rate with loan growth per bank per state to examine the internal capital market across states. The results show that there is no strong significant coefficient in the relationship between deposit rates and loan growth. In addition, we breakdown banks by their capitalization in Panels B and C. For weakly-capitalized banks (Panel B) we find a strong negative relation which is significant at the 1% for accounts of $10k., and $100k. and only for quarter 3 of the pandemic. In contrast, for well-capitalized banks (Panel C) we do not find any significant results. These results indicate that deposit rates are not a dominant factor for banks' lending growth in commercial and industrial loans during the pandemic. Also, we use an alternative lending category: the quarter change in syndicated loans. The results reported in Table A3 in the Appendix, indicate that the internal capital market tool was not used during the pandemic, similar to our findings with new loans and leases and with commercial and industrial loans.[2]

-Please Insert Table 7 here-

[2] In Table A4 in the Appendix, we also test the relationship based on bank size, measured as total assets. The results provide small statistical significance, and provide evidence that capitalization represents a bank characteristic which contains more information for banks' liquidity condition.

4.3 The Relationship between Lending and Deposit Growth

Hitherto, we do not find a strong positive relation between deposit growth and deposit rates, and between deposit rates and loan growth during the COVID-19 pandemic. Since deposits and lending increased during the first phase of the pandemic, the decrease in deposit rates reflect that banks were not stressed on the deposit funding. This also implies that market discipline was not exercised and that the internal capital markets mechanism was not in work during the pandemic. Therefore, next we want to assess the relation between deposit growth and loan growth and whether this relation changed during the pandemic. The data on aggregate deposits suggest that the banking system was successful in strengthening their deposits in the first phase of the crisis. With the unprecedented credit line drawdowns and the subsequent increase in lending, we expect a positive relation between deposit growth and loan growth. The results in Panel A of Table 8 show that bank lending growth increased in line with deposits. Before the pandemic, the results show a negative coefficient, which implies that lending growth moved in the opposite direction of deposit growth. From Panel B and C we find that well-capitalized and large banks have greater ability to fund their lending with their deposits relative to weakly capitalized and small banks.

-Please Insert Table 8 here-

Next, we use quarter-on-quarter change of commercial and industrial loans to assess the relation between growth in lending and deposit growth. The results in Table 9 show that an increase in deposit growth is associated with a strong increase in lending growth during the second phase of the pandemic. Notably, the relationship between these two, was negative before the pandemic, indicating that growth in lending was not funded by deposits. The results from Table 9 also reveal that banks with the higher exposure in Fed's liquidity facilities expand their lending in line with the growth in their deposits. In contrast, banks with low exposure in Fed's liquidity facilities expand their lending only after the first phase of the pandemic.

-Please Insert Table 9 here-

4.3 The Balance-Sheet Mechanism

4.3.1 The Relation between Deposit Rates and Liquidity Risk

In this section we investigate how liquidity-exposed banks adjust their lending, deposit rates and their exposure to the Federal Reserve liquidity facilities in reaction to the liquidity shock during the pandemic. *Banks' liquidity risk is measured through their unused credit commitments, and their wholesale funding minus available cash.* We start by assessing the relation between liquidity risk and deposit rates. To improve their liquidity condition, banks with high unused credit commitments are expected to offer higher deposit rates to increase their deposit flows. We use Certificates of Deposits (CDs) of $10k. accounts of deposit rates in columns (1) and (2) of Table 10 and CDs of $500k. in columns (3) and (4). The results show a strong negative coefficient between liquidity risk and deposit rates, which is significant at 1%. These findings imply that liquidity risk and deposit rates move in the opposite direction. This pattern continues when we test the relation for banks with the higher liquidity risk in Panel B of Table 10, indicating that banks exposed to high liquidity risk did not increase deposit rates to stem deposits outflow. One explanation for this is the surge in precautionary savings during the first phase of the pandemic and a second explanation is that these banks used the liquidity facilities offered by the Fed in order to increase their liquidity levels. We test for the latter in the following sections.

-Please Insert Table 10 here-

4.3.2 The Relation between Deposit Growth and Liquidity Risk

In Table 11 we present results for the relation between deposit growth and liquidity risk. The dataset on aggregate deposits suggest that the banking system was successful in attracting deposits during the pandemic. The results show a strong negative relationship between deposit growth and liquidity risk which is significant at 1%. In columns (5) and (6) the results also

show that banks with the higher exposure to liquidity risk experience the higher decline in their deposits. These results indicate that banks with high liquidity risk are more vulnerable to deposit outflows, since the higher the exposure to liquidity risk, the higher the decline in deposits.

-Please Insert Table 11 here-

4.3.3 The Relation between Lending and Liquidity Risk

We also test how liquidity risk-exposed banks adjust lending in reaction to the liquidity shock. Liquidity risk is measured through: i) off-balance unused credit commitments which are converted into loans and add pressure to banks' liquidity condition; and ii) wholesale loan commitments which are loan commitments the interbank market. We use three categories of loans to measure growth in lending: Commercial and Industrial Loans, Net Loans and Leases, and Syndicated Loans. The results in Table 14 show a positive relationship between Liquidity Risk and growth in Commercial and Industrial Loans. This result is consistent with the dramatic increase in involuntary lending that was caused when firms drewdown credit lines and therefore, off-balance-sheet commitments were converted to loans. In contrast, when we use net loans and leases to test the relationship with liquidity risk in Panel B, we find a strong negative relationship between banks with high exposure to liquidity risk and growth in lending. These results imply that banks with high exposure to liquidity risk respond to liquidity shock by cutting back new lending. Similarly, the findings in Panel C reveal that increased exposure to liquidity risk is associated with a drop in the provision of syndicated loans.

-Please Insert Table 12 here-

4.4 The Relation between Fed's Liquidity Injection and Liquidity Risk

Finally, we assess the relationship between liquidity risk and banks' exposure to the Fed's liquidity facilities. We measure banks' exposure in these liquidity facilities through the quarter-

on-quarter change on the sum of Total Federal Funds sold to Commercial Banks and Reverse Repurchases and Vault Cash and Cash Items and Balances due from Federal Reserve Banks. The results in Table 13 show a strong positive relationship between liquidity risk and banks' exposure to Fed's facilities. Precisely, we find that banks with high exposure to liquidity risk increase their exposure to the liquidity facilities offered by the Fed significantly more than low-liquidity risk exposed bank.

-Please Insert Table 13 here-

5. Robustness check

We present sensitivity tests in Tables 14, and 15. In addition, many sensitivity tests are also presented in the Appendix. In Table 14 we provide robustness test for the supply-side of banks' liquidity creation: the market discipline channel. Precisely, we use a different account of deposit rates, the Certificate of Deposits for $100k. The results show that the relationship between deposit rates and weakly-capitalized banks is positive again. This result supports our initial findings that market discipline was not the dominant factor for deposit rates during the pandemic. Next, we provide sensitivity tests for the demand channel of banks' liquidity creation. We assess the relation between deposit growth, loan growth and deposit rates on the county level for each bank. Deposit rates are measured based on the rate provided in Certificate of Deposits for accounts of $10k. (Panel A) and of $500k. (Panel B), while lending growth is measured through the quarter-on-quarter change of Commercial and Industrial Loans for each bank. From Panel A in Table 15 we find that, the relationship between deposit growth and lending growth is strongly positive, while the relationship with deposit rates is negative. The same pattern continues in Panel B: the relationship between deposit growth and lending growth is strongly positive, while the relationship with deposit rates is negative. All coefficients are significant at 1%. These results indicate that banks' deposit rates move in the opposite direction

of deposit and lending growth, and hence the internal capital market mechanism is not in work during the pandemic.

-Please Insert Table 14 here-

-Please Insert Table 15 here-

6. Conclusion

The COVID-19 pandemic-induced recession brought aggregate shocks to the United States banking system, with liquidity pressure and significant financial disruptions especially across the funding markets. From the onset of the pandemic, households increased their bank savings and the Federal Reserve injected liquidity to stabilize the financial system. This study shows how this expansion of liquidity was distributed across the banking system. In our first set of tests, we find that households increase savings as a precautionary action against future declines in income, while also we find no evidence for the exercise of market discipline by depositors. More precisely, depositors should discipline risky (weakly-capitalized) banks, however deposit rates are not negatively correlated with banks' capitalization, contradicting the market discipline theory for the COVID-19 pandemic period. This implies that during the pandemic weakly-capitalized banks were not forced to offer higher deposit rates to stem deposits outflow, and hence achieved to keep their cost-of-capital in sustainable levels.

Furthermore, we provide strong evidence that deposit growth is positively correlated with lending growth, but negatively correlated with lagged deposit rates. This result indicates that banks' internal capital market was not in work during the pandemic. Next, we assess how liquidity risk in the form of undrawn and wholesale loan commitments affected bank lending activities. In the beginning of the COVID-19 pandemic, undrawn loan commitments materialized as borrowers drew on preexisting commitments to improve their liquidity. Weakly-capitalized banks with high liquidity risk, increased their exposure to the liquidity facilities introduced by the Federal Reserve, more than low-commitments banks. As a result,

banks honored their credit commitments, however these takedowns displaced lending capacity since weakly-capitalized banks adjusted their lending by reducing the origination of new loans. In contrast, well-capitalized banks increased lending in line with the increase in their deposits. Finally, we find that banks with high exposure to Federal Reserve's liquidity facilities originated significantly more loans than banks with lower exposure. In aggregate, our results provide strong evidence that most of the decline in bank lending creation during the height of the pandemic can be explained by the degree of their exposure in liquidity risk and in the Federal Reserve's liquidity facilities.

Our findings are especially relevant for macroprudential and monetary policy makers. Since banks with greater risk to credit line drawdowns reduced their lending more than other banks, monetary policy makers can respond by designing liquidity tools that target the characteristics of these banks in future crises. Accordingly, macroprudential policy makers might wish to use banks' exposure in liquidity risk as a signal for tightening (or loosening) the time-varying loan-to-value ratios, and the counter-cyclical capital buffers. Furthermore, the absence of market discipline from depositors implies that the new deposit insurance framework introduced by the Dodd-Frank act in 2010 enhances financial stability, while also that deposit rates are not reflecting bank riskiness, but rather reveal frictions in access to new funding.

References

Acharya, V., Engle, R.F., Steffen, S., 2021. Why did banks stocks crash during COVID-19? *NBER Working Paper 28559.*

Acharya, V., Mora, N., 2015. A crisis of banks as liquidity providers. *Journal of Finance* 70(1): 1-43.

Ashcraft, A., Campello, M., 2007. Firm balance sheets and monetary policy transmission. *Journal of Monetary Economics* 54: 1515-1528.

Ben-David, I., Palvia, A., Spatt, C., 2017. Banks' internal capital markets and deposit rates. *Journal of Financial and Quantitative Analysis* 52(5): 1797-1826.

Bernanke, B., Gertler, M., Gilchrist, S., 1996. The financial accelerator and the flight to quality. *The Review of Economics and Statistics* 78:1-15.

Bhattacharya, S., Thakor, A., V., 1993. Contemporary banking theory. *Journal of Financial Intermediation* 3: 2-50.

Billett, M.T., Garfinkel, J.A., O'Neal, E.S., 1998. The cost of market versus regulatory discipline in banking. *Journal of Financial Economics* 48(3): 333-358.

Brown, C.O., Dinc, S., 2011. Too many to fail? Evidence of regulatory reluctance in bank failures when the banking sector is weak. *Review of Financial Studies* 24: 1378-1405.

Browning, M., Lusardi, A., 1996. Household saving: Micro theories and micro facts. *Journal of Economic Literature* 34:1797-1785

Boyd, J., Prescott, E.E., 1986. Financial intermediary-coalitions. *Journal of Economic Theory* 38: 211-232.

Calomiris, C., 1999. Building an incentive-compatible safety net. *Journal of Banking and Finance* 23(10): 1499-1519.

Calomiris, C., Kahn, C., 1991. The role of demandable debt in structuring optimal banking arrangements. *American Economic Review* 81(3): 497-513.

Calomiris, C., Mason, J.R., 1997. Contagion and bank failures during the Great Depression: The June 1932 Chicago banking panic. *American Economic Review* 87: 863-883.

Campello, M., 2002. Internal capital markets in financial conglomerates: Evidence from small bank responses to monetary policy. *Journal of Finance* 57: 2773-2805.

Cetorelli, N., Goldberg, L., 2012a. Banking globalization and monetary transmission. *Journal of Finance* 67: 1811-1843.

Cetorelli, N., Goldberg, L., 2012b. Liquidity management of U.S. global banks: Internal capital markets in the Great Recession. *Journal of International Economics* 88: 299-311.

Cornett, M.M., McNutt, J.J., Strahan, P.E., Tehranian, H., 2011. Liquidity risk management and credit supply in the financial crisis. *Journal of Financial Economics* 101: 297-312.

Diamond, D., 1984. Financial intermediation and delegated monitoring. *Review of Economic Studies* 51: 393-414.

Diamond, D., Dybvig, P., 1983. Bank runs, deposit insurance, and liquidity. *Journal of Political Economy* 91: 401-419.

Diamond, D., Rajan, R.G., 2000. A theory of bank capital. *Journal of Finance* 55: 2431-2465.

Gatev, E., Strahan, P.E., 2006. Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market. *Journal of Finance* 61: 867-892.

Goldberg, L.G., Hudgins, S.C., 2002. Depositor discipline and changing strategies for regulating thrift institutions. *Journal of Financial Economics* 63(2): 263-274.

Gorton, G., 1988. Banking panics and business cycles. *Oxford Economic Papers* 40: 751-781.

Hasan, I., Politsidis, P.N., Sharma, Z., 2021. Global syndicated lending during the COVID-19 pandemic. *Journal of Banking and Finance* forthcoming.

Hett, F., Schmidt, A., 2017. Bank rescues and bailout expectations: The erosion of market discipline during the financial crisis. *Journal of Financial Economics* 126: 635-651.

Holstrom, B., Tirole, J., 1998. Private and public supply of liquidity. *Journal of Political Economy* 106(1): 1-40.

Houston, J., James, C., Marcus, D., 1997. Capital market frictions and the role of internal capital markets in banking? *Journal of Financial Economics* 46: 135-164.

Ivashina, V., 2009. Asymmetric information effects on loan spreads. *Journal of Financial Economics* 92(2): 300-319.

Ivashina, V., Scharfstein, D., 2010. Bank lending during the financial crisis of 2008. *Journal of Financial Economics* 97(3): 319-338.

Kashyap, A.K., Rajan, R., Stein, J.C., 2002. Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking. *The Journal of Finance* 57(1): 33-73.

Li, L., Strahan, P.E., Zhang, S., 2020. Banks as lenders of first resort: Evidence from the COVID-19 crisis. *The Review of Corporate Finance Studies* 9(3): 472-500.

Martinez-Peria, M.S., Schmukler, S.L., 2001. Do depositors punish banks for bad behavior? Market discipline, deposit insurance, and banking crises? *Journal of Finance* 56(3): 1029-1051.

Park, S., Peristiani, S., 1998. Market discipline by thrift depositors. *Journal of Money, Credit, and Banking* 30: 347-364.

Peria, M.S., Schmukler, S.L., 2001. Do depositors punish banks for bad behavior? Market discipline, deposit insurance, and banking crises. *Journal of Finance* 56: 1029-1051.

Ramakrishnan, R.T.S., Thakor, A.V., 1984. Information reliability and a theory of financial intermediation. *Review of Economic Studies* 51: 415-432.

Saunders, A., Wilson, B., 1996. Contagious bank runs: Evidence from the 1929-1933 period. *Journal of Financial Intermediation* 5: 409-423.

Figure 1. Aggregate deposits. This figure shows the quarterly aggregate deposits from 2016 till 2020.

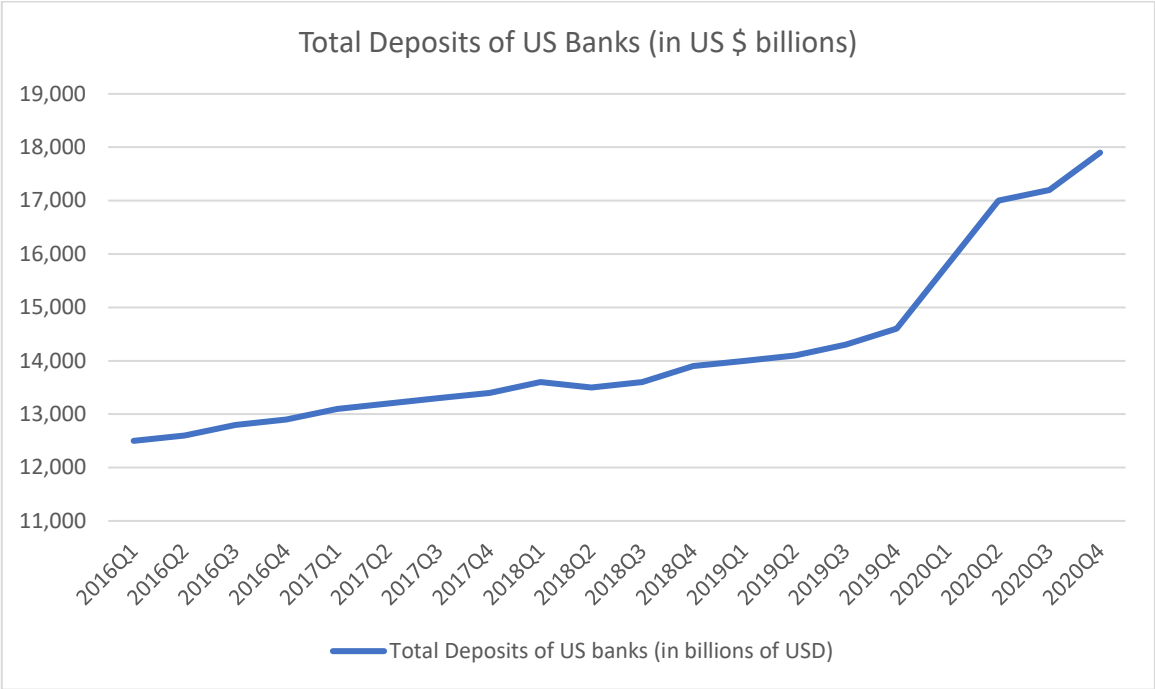

Figure 2. Unused credit commitments to total assets. This figure shows the quarterly ratio of unused credit commitments (Liquidity Risk) to total assets 2016 till 2020.

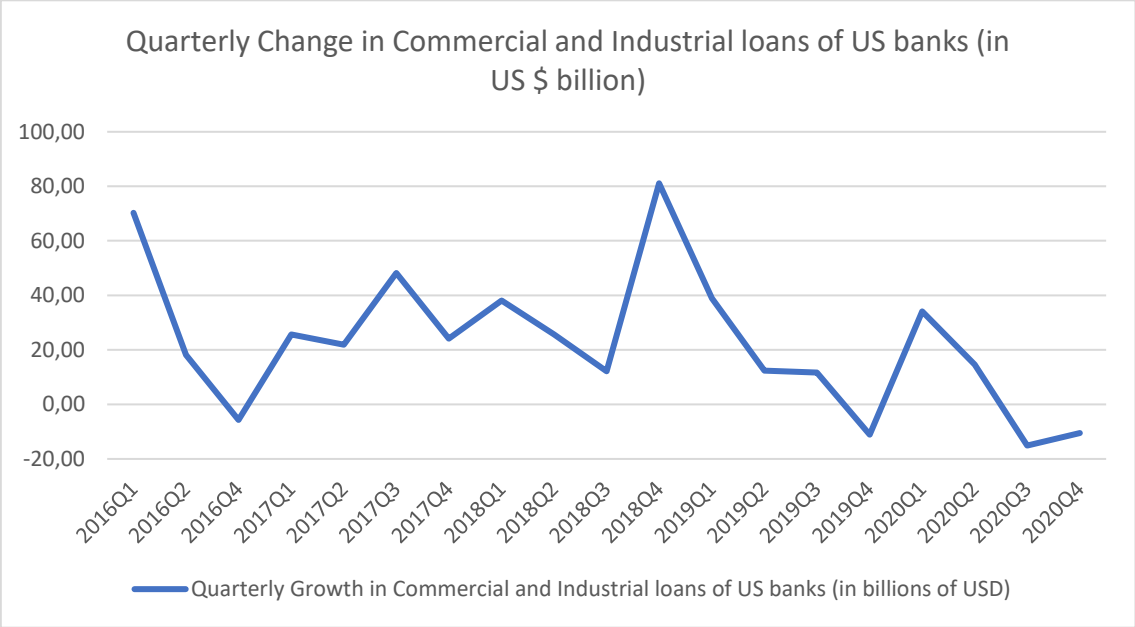

Table 1. Summary Statistics

This table presents summary statistics for the variables used in the analysis. The sample period is from 2016Q1-2020Q4. Panel A and Panel B show summary statistics for the analysis for the main sample. Panel C shows summary statistics for the sample with deposit rates for a variety of account sizes per bank per branch.

Panel A. Summary Statistics of Main Sample (bank-quarter observations) amounts in US$ millions.

	N	Mean	Std.Dev	P5	P25	P50	P75	P95
Total Assets	105,632	3,252.2	51,600.0	36.7	102.5	218.7	525.5	3740.4
Total Deposits	105,642	2,512.6	39,000.0	29.6	85.5	183.6	437.8	2963.1
Total Equity	105,471	359.7	5,354.0	4.4	11.9	24.8	59.2	411.0
Commercial and Industrial loans	105,642	387.8	5,988.6	0.2	1.3	14.1	43.2	393.8
Net Loans and Leases	105,632	1,768.0	24,100.0	16.5	59.4	140.7	359.0	2563.7
Total Unused Commitments	105,642	1,388.8	24,500.0	0.7	6.3	19.6	62.5	602.5
Total Federal Reserve Repurchase	105,632	91.7	3,605.6	0.0	0.0	0.0	1.6	14.6
Cash	105,632	358.5	7,527.5	2.2	6.9	15.1	36.3	209.0
Syndicated loans	5,206	9,280.0	22,300.0	0.0	81.3	652.0	6,490.0	54100.0

Panel B. Summary Statistics of ratios in Main Sample (bank-quarter observations)

	N	Mean	Std.Dev	P5	P25	P50	P75	P95
Total Equity to Assets ratio	105,471	0.123	0.069	0.081	0.096	0.110	0.130	0.188
Total Deposits to Assets ratio	105,642	0.829	0.092	0.705	0.804	0.848	0.879	0.907
Total Liabilities to Total Assets ratio	105,642	0.878	0.070	0.812	0.870	0.890	0.904	0.920
Unused Commitments ratio	104,995	0.137	0.090	0.025	0.084	0.128	0.174	0.259

Panel C. Summary Statistics of Deposit Rates (bank-quarter observations)

	N	Mean	Std.Dev	P5	P25	P50	P75	P95
12-month CD rate, $10k accounts (12MCD10K rate)	83,565	0.658	0.486	0.150	0.300	0.500	0.900	1.730
12-month CD rate, $100k accounts (12MCD100K rate)	80,787	0.686	0.496	0.150	0.341	0.500	0.950	1.750
12-month CD rate, $500k accounts (12MCD500K rate)	71,679	0.708	0.507	0.150	0.350	0.520	1.000	1.760

Table 2. Deposit Rates, Deposit growth and Covid-19 cases

This table presents regressions of deposit rates, deposit growth and Covid-19 cases per capita. Panel A presents the regression results that estimate the effect of COVID-19 on deposit rates. Panel B presents the regression results that estimate the effect of COVID-19 in the growth of deposits. In columns (1) and (3) the independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results for Q3 2020.In columns (2) and (4) the independent variables are lagged by 2 quarters (i=2) and therefore for the pandemic period it reflects results for Q2 2020. The sample is from March 2020 till December 2020 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit rates and Covid-19 cases	12-Month CD $10k account rate		12-Month CD $500k account rate	
	(1)	(2)	(1)	(2)
	i=1	i=2	i=1	i=2
Covid-19 cases per capita (t-i)	-2.000***	-2.000***	-0.976	-2.812
	(37.17)	(37.16)	(0.27)	(0.65)
State Fixed effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.0913	0.0913	0.0741	0.0741
No. of obs.	41,491	41,484	4,097	4,097

Panel B. Deposit growth and Covid-19 cases	Deposit growth (in thousands of $)		Deposit to total assets growth (in %)	
	(1)	(2)	(1)	(2)
	i=1	i=2	i=1	i=2
Covid-19 cases per capita (t-i)	2,388.1*	2,423.7*	0.009	0.011
	(1.73)	(1.65)	(0.87)	(0.97)
State Fixed effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.0133	0.0133	0.0155	0.0155
No. of obs.	15,222	15,222	15,222	15,222

Table 3. Deposit Rates and Bank Tier 1 Ratio

This table presents regressions of 12-month Certificate of Deposits (CD) rates on lagged Tier 1 Capital to Risk-Weighted-Assets Ratio. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Whole sample	Dependent Variables:	12-Month CD $10k account rate		12-Month CD $500k account rate	
		(1)	(2)	(1)	(2)
		i=1	i=3	i=1	i=3
Equity to assets (t-i) × I *(q<2020Q1)*		0.005***	0.006***	0.005***	0.006***
		(7.40)	(8.61)	(6.25)	(7.48)
Equity to assets (*t-i*) × I (*q≥2020Q1)*		0.002***	0.003***	0.004***	0.004***
		(2.95)	(3.84)	(3.19)	(3.72)
Bank Fixed effects		Yes	Yes	Yes	Yes
Quarter Fixed Effects		Yes	Yes	Yes	Yes
R-squared		0.703	0.703	0.724	0.724
No. of obs.		83,565	83,565	71,679	71,679

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% lower-capitalized banks)	Dependent Variables: 12-Month CD $10k account rate		12-Month CD $500k account rate	
	(1)	(2)	(1)	(2)
	i=1	i=3	i=1	i=3
Equity to assets (t-i) × I (q<2020Q1)	0.006	0.013**	0.016**	0.019***
	(1.02)	(2.01)	(2.35)	(2.71)
Equity to assets (*t-i*) × I (*q≥2020Q1)*	0.020**	0.029***	0.028*	0.023
	(2.03)	(2.78)	(1.84)	(1.48)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-square	0.740	0.739	0.770	0.765
No. of obs.	8,062	8,072	6,861	6,875

Table 4. Deposit Growth, Net Loans and Leases Growth, and Deposit Rates of Small Accounts

This table presents regressions of quarter-on-quarter deposits growth on lagged quarter-on-quarter loan growth and 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $10k. Loan growth is defined as quarterly change in net loans and leases. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit Growth, Loan Growth and Deposit Rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* × I (q<2020Q1)			17.866	-7.624
			(0.85)	(0.33)
12-Month CD $10k account rate *(t-i)* × I (*q≥2020Q1)*			-309.194***	-319.647***
			(8.55)	(10.17)
Net loans and Leases Growth *(t-i)* × I (q<2020Q1)	-0.384***	-0.119***	-0.385***	-0.132***
	(39.73)	(11.73)	(37.16)	(12.04)
Net loans and Leases Growth *(t-i)* × I (q≥2020Q1)	0.587***	0.121***	0.601***	0.1076***
	(85.77)	(14.65)	(83.74)	(12.40)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.289	0.227	0.318	0.248
No. of obs.	105,581	105,552	83,520	83,451

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* × I (q<2020Q1)			12.479	2.003
			(0.67)	(0.10)
12-Month CD $10k account rate *(t-i)* × I (*q≥2020Q1)*			-63.529**	-46.218*
			(2.02)	(1.73)
Net loans and Leases Growth *(t-i)* × I (q<2020Q1)	-1.551***	-0.571***	-0.818***	0.254***
	(11.84)	(3.92)	(15.48)	(4.20)
Net loans and Leases Growth *(t-i)* × I (q≥2020Q1)	-0.802***	1.138***	-0.354***	0.109**
	(10.39)	(10.97)	(10.78)	(2.30)

Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.289	0.135	0.261	0.182
No. of obs.	10,536	10,533	8,054	8,044

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% highly-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* × I (q<2020Q1)			-33.341	-25.561
			(1.55)	(1.07)
12-Month CD $10k account rate *(t-i)* × I (*q≥2020Q1)*			-50.141	-67.307**
			(1.33)	(1.99)
Net loans and Leases Growth *(t-i)* × I (q<2020Q1)	-0.248***	0.441***	-0.089***	-0.010
	(11.35)	(19.68)	(3.27)	(0.35)
Net loans and Leases Growth *(t-i)* × I (q≥2020Q1)	0.216***	0.374***	0.129***	0.337***
	(4.31)	(6.62)	(3.11)	(6.97)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.114	0.184	0.178	0.252
No. of obs.	10,680	10,677	6,905	6,912

Table 5. Deposit growth, Commercial and Industrial Loans Growth, and Deposit Rates of Small Accounts

This table presents regressions of quarter-on-quarter deposits growth on lagged quarter-on-quarter loan growth and 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $10k. Loan growth is defined as quarterly change in net loans and leases. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit Growth, Loan Growth and Deposit Rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* * I (q<2020Q1)			13.774	-3.761
			(0.67)	(0.16)
12-Month CD $10k account rate *(t-i)* * I (*q≥2020Q1)*			-298.991***	-341.083***
			(8.41)	(10.87)
Commercial and Industrial Loans *(t-i)* * I (q<2020Q1)	-1.033***	-0.441***	-1.050***	-0.430***
	(39.67)	(16.25)	(38.52)	(14.95)
Commercial and Industrial Loans *(t-i)* * I (q≥2020Q1)	-0.299***	1.299***	-0.307***	1.312***
	(19.61)	(101.88)	(19.17)	(98.70)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.229	0.310	0.250	0.341
No. of obs.	105,581	105,552	83,520	83,451

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* * I (q<2020Q1)			11.539	3.158
			(0.61)	(0.16)
12-Month CD $10k account rate *(t-i)* * I (*q≥2020Q1)*			-46.136	-51.278*
			(1.45)	(1.92)
Commercial and Industrial Loans *(t-i)* * I (q<2020Q1)	-3.398***	-2.628***	-0.738***	0.404**
	(9.12)	(6.89)	(4.84)	(2.53)
Commercial and Industrial Loans *(t-i)* * I (q≥2020Q1)	-0.476***	-0.260	-0.344***	-0.510***

	(3.19)	(0.84)	(6.38)	(3.98)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.281	0.123	0.238	0.182
No. of obs.	10,536	10,533	8,054	8,044

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $10k account rate *(t-i)* * I (q<2020Q1)			-30.407	-25.385
			(1.49)	(1.07)
12-Month CD $10k account rate *(t-i)* * I (*q≥2020Q1)*			-46.110	-63.929*
			(1.29)	(1.90)
Quarter change in commercial and industrial loans *(t-i)* * I (q<2020Q1)	1.564***	-0.416***	1.921***	-0.672***
	(17.48)	(4.53)	(25.13)	(8.11)
Quarter change in commercial and industrial loans *(t-i)* * I (q≥2020Q1)	0.736***	0.798***	0.681***	0.813***
	(6.42)	(5.59)	(7.51)	(6.92)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.131	0.152	0.257	0.259
No. of obs.	10,680	10,677	6,905	6,912

Table 6. Deposit rates and Net Loans and Leases Growth

This table presents regressions of 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $10k., 100k., and $500k. Loan growth is defined as quarterly change in net loans and leases. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. Independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. Also, independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Whole sample	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) * I (q<2020Q1)	-0.0015	0.0003	-0.0009	0.0033*	-0.0020	0.0003
	(0.91)	(0.16)	(0.49)	(1.73)	(1.03)	(0.16)
Loan Growth (t-i) * I (q≥2020Q1)	0.0001	0.0025*	0.0002	0.0022	0.0001	0.0006
	(0.08)	(1.66)	(0.15)	(1.47)	(0.05)	(0.36)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7031	0.7031	0.7064	0.7064	0.7239	0.7239
No. of obs.	83,554	83,545	80,813	80,804	71,674	71,666

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) * I (q<2020Q1)	0.0201	0.0808**	-0.0184	-0.0185	-0.1190**	-0.0388
	(0.56)	(2.00)	(0.51)	(0.45)	(2.35)	(0.76)
Loan Growth (t-i) * I (q≥2020Q1)	-0.0445**	0.0565*	-0.0490**	-0.0254	-0.1230	-0.0155
	(2.01)	(1.81)	(2.19)	(0.80)	(1.60)	(0.23)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7404	0.7390	0.7460	0.7459	0.7700	0.7651
No. of obs.	8,062	8,072	7,798	7,810	6,861	6,875

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) * I (q<2020Q1)	0.0010	0.0208*	0.0187	0.0215*	0.0126	0.0141

	(0.85)	(1.81)	(1.59)	(1.84)	(1.08)	(1.18)
Loan Growth (t-i) * I (q>=2020Q1)	0.0600**	0.0136	0.0538**	0.0203	0.0691**	-0.0243
	(2.56)	(0.51)	(2.26)	(0.75)	(2.27)	(0.79)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7429	0.7460	0.7471	0.7506	0.7706	0.7747
No. of obs.	10,982	11,019	10,537	10,578	9,364	9,397

Table 7. Deposit rates and Commercial and Industrial Loan Growth

This table presents regressions of 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $10k., 100k., and $500k. Loan growth is defined as quarterly change in Commercial and Industrial Loans. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. Independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. Also, independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Whole sample

	Dependent Variables					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) * I (q<2020Q1)	-0.0050	-0.0059	0.0004	-0.0022	0.0012	-0.0025
	(1.00)	(1.20)	(0.09)	(0.45)	(0.23)	(0.48)
Loan Growth (t-i) * I (q≥2020Q1)	-0.0016	0.0041	0.0014	0.0036	0.0033	0.0022
	(0.67)	(1.50)	(0.57)	(1.30)	(0.89)	(0.33)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7031	0.7031	0.7064	0.7064	0.7239	0.7239
No. of obs.	83,554	83,545	80,813	80,804	71,674	71,666

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) × I (q<2020Q1)	0.0998	0.2070**	0.0777	-0.1680	-0.0542	0.2230**
	(0.98)	(2.07)	(0.76)	(1.57)	(0.53)	(2.01)
Loan Growth (t-i) × I (q≥2020Q1)	-0.1130***	0.0299	-0.1190***	-0.1640*	-0.9670	0.2080
	(3.16)	(0.35)	(3.29)	(1.92)	(1.29)	(0.64)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7406	0.7390	0.7462	0.7461	0.7698	0.7653

No. of obs.	8,062	8,072	7,798	7,810	6,861	6,875

Panel D. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Loan Growth (t-i) * I (q<2020Q1)	0.0022	0.0047	0.0025	0.0233	0.0082	-0.0025
	(0.04)	(0.10)	(0.05)	(0.46)	(0.16)	(0.05)
Loan Growth (t-i) * I (q≥2020Q1)	0.0200	0.0167	0.01320	0.0456	0.2190	-0.1990
	(0.34)	(0.24)	(0.22)	(0.64)	(1.47)	(1.26)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7493	0.7533	0.7539	0.7565	0.7740	0.7754
No. of obs.	6,925	6,952	6,642	6,669	5,890	5,917

Table 8. Loan Growth and Deposit Growth

This table presents regressions of quarter-on-quarter loan growth on lagged quarter-on-quarter deposits growth. In columns (1) and (2) the dependent variable is net loans and leases growth and the independent is deposits growth. In columns (3) and (4) the dependent variable is net loans and leases to total assets growth and the independent is deposits to total assets growth. In Panel A the whole sample of banks is used. Panel B separates the sample by bank capitalization using the bottom 10% decile. Panel C separates the sample by bank capitalization using the top 10% decile. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Whole sample	Dependent Variables: Quarter-on-quarter Loans Growth		Quarter-on-quarter Loans to Assets Growth	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Deposits growth (t-i) * I (q<2020Q1)	-0.3842***	-0.1193***	-0.0301*	0.0335**
	(39.73)	(11.73)	(1.95)	(2.17)
Deposits growth (t-i) * I (q≥2020Q1)	0.5871***	0.1205***	0.0259**	0.0389***
	(85.77)	(14.65)	(2.37)	(3.11)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.2892	0.2275	0.0634	0.0562
No. of obs.	105,581	105,552	105,581	105,552

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)	Dependent Variables: Quarter-on-quarter Loans Growth		Quarter-on-quarter Loans to Assets Growth	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Deposits growth (t-i) * I (q<2020Q1)	-1.5514***	-0.5714***	0.3110	-0.0266
	(11.84)	(3.92)	(1.13)	(0.88)
Deposits growth (t-i) * I (q≥2020Q1)	-0.8024***	1.1375***	-0.0434	0.0392
	(10.39)	(10.97)	(0.27)	(0.17)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.2895	0.1356	0.1711	0.1378

No. of obs.	10,536	10,533	10,536	10,533

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)	Dependent Variables: Quarter-on-quarter Loans Growth		Quarter-on-quarter Loans to Assets Growth	
	(1)	(2)	(3)	(4)
	(i=1)	(i=2)	(i=3)	(i=4)
Deposits growth (t-i) * I (q<2020Q1)	-0.2478***	0.4409***	-0.2910**	0.0843
	(11.35)	(19.68)	(2.19)	(0.62)
Deposits growth (t-i) * I (q≥2020Q1)	0.2161***	0.3742***	0.5260*	0.9020***
	(4.31)	(6.62)	(1.72)	(2.64)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.1142	0.1840	0.2468	0.1367
No. of obs.	10,680	10,677	10,680	10,677

Table 9. Loan Growth, Federal Reserve Liquidity and Deposit Growth

This table presents regressions of quarter-on-quarter loan to total assets growth on lagged quarter-on-quarter deposits to total assets growth. In Panel A columns (1) and (2) the dependent variable is commercial and industrial loans growth and the independent is deposits to total assets growth before the pandemic. In columns (3) and (4) the dependent variable is commercial and industrial loans to total assets growth and the independent is deposits to total assets growth during the pandemic. In Panel A the whole sample of banks is used. Panel B separates the sample by banks' exposure to Federal Reserve Liquidity Facilities (denoted as FL) using the bottom and top 10% deciles. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Whole Sample	Dependent Variable: Δ Commercial and Industrial Loans to Total Assets			
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Deposits to total assets growth (t-i) × I (<2020)	-0.006***	-0.001		
	(3.67)	(0.85)		
Deposits to total assets growth (t-i) × I (≥2020)			0.129***	0.0142
			(12.34)	(1.03)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.0683	0.0667	0.5084	0.5009
No. of obs.	90,351	90,331	15,230	15,221

	Dependent Variable: Δ Commercial and Industrial Loans to Total Assets			
Panel B. Pandemic Period	Lower 10% with exposure to Fed's Liquidity		Higher 10% with exposure to Fed's Liquidity	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Deposits to total assets growth (t-i) × I (≥2020) × ***FL***	0.146***	-0.071*	0.061**	0.086**
	(3.79)	(1.73)	(2.11)	(2.16)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.6447	0.5490	0.4914	0.4916
No. of obs.	1,522	1,521	1,523	1,523

Table 10. Deposit rates and Liquidity Risk

This table presents regressions of 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter liquidity risk. The CD rates are for accounts of $10k., and $500k. Liquidity risk is defined as quarterly change in Unused Credit Commitments and Wholesale Funding. In Panel A the whole sample of banks is used. Panel B presents results for banks with the higher (top 10%) exposure to liquidity risk. Independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. Also, independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variables:			
Panel A. Whole sample	12-Month CD $10k rate		12-Month CD $500k rate	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	-0.1641***	-0.1523***	-0.1906***	-0.1943***
	(4.03)	(3.72)	(4.13)	(4.21)
Liquidity Risk (t-i) * I (q≥2020Q1)	-0.3021***	-0.3053***	-0.3345***	-0.3670***
	(6.11)	(6.25)	(5.04)	(5.50)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.7033	0.7033	0.7240	0.7240
No. of obs.	83,565	83,565	71,679	71,679

	Dependent Variables:			
Panel B. Banks with higher Liquidity Risk (top 10%)	12-Month CD $10k rate		12-Month CD $500k rate	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	-0.4710***	-0.4278***	-0.4273***	-0.3170**
	(4.36)	(3.74)	(3.17)	(2.27)
Liquidity Risk (t-i) * I (q≥2020Q1)	-0.7390***	-0.7191***	-0.5374***	-0.4195**
	(5.83)	(5.63)	(2.93)	(2.28)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.7468	0.7438	0.7658	0.7646
No. of obs.	7,969	7,995	6,628	6,644

Table 11. Deposit Growth and Liquidity Risk

This table presents regressions of quarter-on-quarter deposits to total assets growth on lagged quarter-on-quarter liquidity risk. In columns (1) and (2) the whole sample of banks is included. In columns (3) and (4) the sample is separated to banks with lower (bottom 10%) exposure to liquidity risk. In columns (5) and (6) the sample includes banks with higher (top 10%) exposure to liquidity risk. In columns (1), (3) and (5) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2), (4), and (6) independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Deposits to total assets growth					
	Whole sample of Banks		Lower 10% of Liquidity Risk Banks		Higher 10% of Liquidity Risk Banks	
	(1)	(2)	(3)	(4)	(5)	(6)
	(i=1)	(i=3)	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	-4.2251***	-2.2994***	-5.2655	-1.3958	-6.2469***	-6.8107***
	(14.84)	(8.13)	(1.33)	(0.88)	(6.79)	(7.46)
Liquidity Risk (t-i) * I (q≥2020Q1)	-3.6686***	-1.9597***	-9.5066	-5.1037	-5.8180***	-6.2368***
	(10.75)	(5.83)	(1.63)	(1.21)	(5.75)	(6.21)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.0768	0.0754	0.2278	0.2279	0.1886	0.1799
No. of obs.	105,611	105,611	10,487	10,436	11,129	11,154

Table 12. Loans Growth and Liquidity Risk

This table presents regressions of quarter-on-quarter lending growth on lagged quarter-on-quarter liquidity risk. Panel A reports results for *Commercial and Industrial (C&I) Loans*, Panel B reports results for *Net Loans and Leases*, and Panel C for *Syndicated Loans*. In columns (1) and (2) the sample includes banks with higher (top 10%) exposure to liquidity risk. In columns (3) and (4) the sample includes banks with lower (bottom 10%) exposure to liquidity risk. In columns (1), and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2), and (4) independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: C&I Loans Growth and Liquidity Risk	Dependent Variable: Δ Commercial and Industrial Loans			
	Higher 10% of Liquidity Risk Banks		Lower 10% of Liquidity Risk Banks	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	89.066*	103.071**	-26.175	-1.236
	(1.73)	(2.02)	(0.81)	(0.10)
Liquidity Risk (t-i) * I (q≥2020Q1)	202.036***	223.717***	4.344	145.474***
	(3.27)	(3.69)	(0.09)	(4.25)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.0443	0.0444	0.1193	0.1162
No. of obs.	11,129	11,154	10,487	10,436
Panel B: Net Loans and Leases Growth and Liquidity Risk	Dependent Variable: Δ Net Loans and Leases			
	Higher 10% of Liquidity Risk Banks		Lower 10% of Liquidity Risk Banks	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	359.191***	195.909*	25.230	-575.118***
	(3.52)	(1.93)	(0.09)	(5.21)
Liquidity Risk (t-i) * I (q≥2020Q1)	-243.094**	-418.632**	665.850	176.158
	(1.99)	(3.48)	(1.63)	(0.60)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.0978	0.0977	0.0682	0.0713
No. of obs.	11,129	11,154	10,487	10,436
Panel C: Syndicated Loans Growth and Liquidity Risk	Dependent Variables: Syndicated Loans			

	Whole sample of Banks		Lower 10% of Liquidity Risk Banks		Higher 10% of Liquidity Risk Banks	
	(1)	(2)	(3)	(4)	(5)	(6)
	(i=1)	(i=3)	(i=1)	(i=3)	(i=1)	(i=3)
Liquidity Risk (t-i) * I (q<2020Q1)	-19.664*	-11.464	-297.833	0.586	-27.065	-24.566
	(1.64)	(1.23)	(1.34)	(0.04)	(1.57)	(1.43)
Liquidity Risk (t-i) * I (q≥2020Q1)	-55.565***	-47.065***	126.860	175.900	-108.039***	-102.291***
	(4.38)	(4.53)	(0.74)	(1.47)	(5.55)	(5.31)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.8222	0.8218	0.6577	0.6487	0.8367	0.8363
No. of obs.	1,706	1,706	183	182	971	972

Table 13. Liquidity Risk and Federal Reserve Liquidity Facilities

This table presents regressions of quarter-on-quarter change in liquidity risk on lagged change in Fed's liquidity facilities. In columns (1) and (2) the sample includes banks with higher (top 10%) exposure to liquidity risk. In columns (3) and (4) the sample includes banks with lower (bottom 10%) exposure to liquidity risk. In columns (1), and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2), and (4) independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variable: Δ Liquidity Risk			
	Higher 10% Liquidity Risk Banks		Lower 10% Liquidity Risk Banks	
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
Δ Fed Liquidity (t-i) × I (q<2020Q1)	0.0026	0.0289***	0.0371***	-0.0060
	(0.29)	(3.07)	(8.31)	(1.29)
Δ Fed Liquidity (t-i) × I (q≥2020Q1)	0.0601***	0.0408*	-0.0039	-0.0146
	(3.13)	(1.85)	(0.44)	(1.28)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.9542	0.9502	0.6113	0.6107
No. of obs.	10,488	10,488	10,472	10,418

Table 14. Deposit Rate and Bank Tier 1 Ratio

This table presents regressions of 12-month Certificate of Deposits (CD) rates on lagged Tier 1 Capital to Risk-Weighted-Assets Ratio. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: 12-Month CD $100k rate					
	Whole Sample		Lower 10% by Capitalization		Higher 10% by Capitalization	
	(1)	(2)	(3)	(4)	(5)	(6)
	(i=1)	(i=3)	(i=1)	(i=3)	(i=1)	(i=3)
Equity to Assets ratio *(t-i)* × *I (<2020)*	0.0024***	0.0025***	0.0642***	0.0681***	0.0013*	0.0012
	(6.00)	(6.14)	(9.00)	(9.55)	(1.80)	(1.57)
Equity to Assets ratio *(t-i)* × I *(≥2020)*	0.0004	0.0007	0.0153**	0.0298***	-0.0019	-0.0021
	(0.65)	(1.03)	(2.02)	(3.82)	(1.46)	(1.56)
Bank Fixed Effects	Y	Y	Y	Y	Y	Y
Quarter Fixed Effects	Y	Y	Y	Y	Y	Y
R-squared	0.7045	0.7064	0.7592	0.7582	0.7545	0.756
Observations	122,538	117,877	12,241	11,774	12,241	11,774

Table 15. Deposit Growth, Loan Growth and Deposit Rates

This table presents regressions of quarter-on-quarter deposits growth on lagged quarter-on-quarter loan growth and 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. In Panel A, the CD rates are for accounts of $10k and in Panel B for accounts of $500k. Loan growth is defined as quarterly change in net loans and leases. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit Growth, Loan Growth and 12-Month CD $10k rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
12MCD10K rate *(t-i)* × I (q<2020Q1)			137.182	-28.770
			(0.82)	(0.16)
12MCD10K rate *(t-i)* × I (*q≥2020Q1)*			-1757.555***	-1864.103***
			(5.59)	(6.96)
Net Loans and Leases Growth *(t-i)* × I (q<2020Q1)	-0.377***	-0.108***	-0.377***	-0.119***
	(12.26)	(3.35)	(11.65)	(3.47)
Net Loans and Leases Growth *(t-i)* × I (q≥2020Q1)	0.570***	0.107***	0.578***	0.084
	(26.22)	(4.08)	(25.78)	(3.11)
Bank Fixed effects	Y	Y	Y	Y
Quarter Fixed Effects	Y	Y	Y	Y
R-squared	0.2907	0.2321	0.3220	0.2561
No. of obs.	10,552	10,548	8,621	8,616

Panel B. Deposit Growth, Loan Growth and 12-Month CD $500k rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	(i=1)	(i=3)	(i=1)	(i=3)
12MCD500K rate *(t-i)* × I (q<2020Q1)			-20.795	30.749
			(0.12)	(0.17)
12MCD500K rate *(t-i)* × I (*q≥2020Q1)*			-1705.219***	-1474.226***
			(5.03)	(5.50)
Net Loans and Leases Growth (t-i) × I (q<2020Q1)	-0.377***	-0.108***	-0.342***	-0.096***

	(12.26)	(3.35)	(10.28)	(2.88)
Net Loans and Leases Growth *(t-i)* × I (q≥2020Q1)	0.570***	0.107***	0.636***	0.066**
	(26.22)	(4.08)	(26.46)	(2.50)
Bank Fixed effects	Y	Y	Y	Y
Quarter Fixed Effects	Y	Y	Y	Y
R-squared	0.2907	0.2321	0.3250	0.2502
No. of obs.	10,552	10,548	7,703	8,519

Appendix with Supplementary Materials

Banks' Liquidity Management During the COVID-19 Pandemic

Appendix A. Robustness Analysis

Table A1. Deposit growth, Net Loans and Leases Growth, and Deposit Rates of Large Accounts

This table presents regressions of quarter-on-quarter deposits growth on lagged quarter-on-quarter loan growth and 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $500k. Loan growth is defined as quarterly change in net loans and leases. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit Growth, Loan Growth and Deposit Rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* × I (q<2020Q1)			-6.099	29.469
			(0.28)	(1.27)
12-Month CD $500k account rate *(t-i)* × I (*q≥2020Q1)*			-275.610***	-222.678***
			(7.26)	(7.05)
Net Loans and Leases *(t-i)* × I (q<2020Q1)	-0.384***	-0.119***	-0.347***	-0.106***
	(39.73)	(11.73)	(32.84)	(9.56)
Net Loans and Leases *(t-i)* × I (q≥2020Q1)	0.587***	0.121***	0.658***	0.0769***
	(85.77)	(14.65)	(86.09)	(8.89)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.289	0.227	0.322	0.248
No. of obs.	105,581	105,552	75,691	78,532

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* × I (q<2020Q1)			12.479	2.003

			(0.67)	(0.10)
12-Month CD $500k account rate *(t-i)* × I (*q≥2020Q1)*			-63.529**	-46.218*
			(2.02)	(1.73)
Net Loans and Leases *(t-i)* × I (q<2020Q1)	-1.551***	-0.571***	-0.818***	0.254***
	(11.84)	(3.92)	(15.48)	(4.20)
Net Loans and Leases *(t-i)* × I (q≥2020Q1)	-0.802***	1.138***	-0.354***	0.109**
	(10.39)	(10.97)	(10.78)	(2.30)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.289	0.135	0.261	0.182
No. of obs.	10,536	10,533	8,054	8,044

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% highly-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* × I (q<2020Q1)			-33.341	-25.561
			(1.55)	(1.07)
12-Month CD $500k account rate *(t-i)* × I (*q≥2020Q1)*			-50.141	-67.307**
			(1.33)	(1.99)
Net Loans and Leases *(t-i)* × I (q<2020Q1)	-0.248***	0.441***	-0.089***	-0.010
	(11.35)	(19.68)	(3.27)	(0.35)
Net Loans and Leases *(t-i)* × I (q≥2020Q1)	0.216***	0.374***	0.129***	0.337***
	(4.31)	(6.62)	(3.11)	(6.97)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.114	0.184	0.178	0.252
No. of obs.	10,680	10,677	6,905	6,912

Table A2. Deposit Growth, Commercial and Industrial Loans Growth, and Deposit Rates of Large Accounts

This table presents regressions of quarter-on-quarter deposits growth on lagged quarter-on-quarter loan growth and 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $500k. Loan growth is defined as quarterly change in net loans and leases. In Panel A the whole sample of banks is used. Panel B splits the sample by bank capitalization using the bottom 10% decile. Panel C splits the sample by bank capitalization using the top 10% decile. In columns (1) and (3) independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. In columns (2) and (4) the independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Deposit Growth, Loan Growth and Deposit Rates

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* * I (q<2020Q1)			-7.972	31.865
			(0.38)	(1.38)
12-Month CD $500k account rate *(t-i)* * I (*q≥2020Q1)*			-263.759***	-242.399***
			(7.15)	(7.71)
Commercial and Industrial Loans *(t-i)* * I (q<2020Q1)	-1.033***	-0.441***	-0.930***	-0.444***
	(39.67)	(16.25)	(33.69)	(15.34)
Commercial and Industrial Loans *(t-i)* * I (q>=2020Q1)	1.299***	-0.299***	1.550***	-0.383***
	(101.88)	(19.61)	(108.68)	(22.73)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.310	0.229	0.359	0.253
No. of obs.	105,581	105,552	75,691	78,532

Panel B. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* * I (q<2020Q1)			37.043**	15.877
			(2.10)	(0.85)
12-Month CD $500k account rate *(t-i)* * I (*q≥2020Q1)*			41.619	-4.487
			(1.37)	(0.18)
Commercial and Industrial Loans *(t-i)* * I (q<2020Q1)	-3.398***	-2.628***	-0.443***	0.308**
	(9.12)	(6.89)	(3.25)	(2.12)
Commercial and Industrial Loans *(t-i)* * I (q≥2020Q1)	-0.476***	-0.260	-2.082***	-0.603***
	(3.19)	(0.84)	(18.20)	(5.19)

Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.281	0.123	0.368	0.226
No. of obs.	10,536	10,533	7,254	7,538

Panel C. Deposit Rates and Bank Tier 1 Capital to Risk-Weighted-Assets Ratio (10% low-capitalized banks)

	Dependent Variable: Deposit Growth			
	(1)	(2)	(3)	(4)
	i=1	i=3	i=1	i=3
12-Month CD $500k account rate *(t-i)* * I (q<2020Q1)			-40.998*	-15.793
			(1.88)	(0.64)
12-Month CD $500k account rate *(t-i)* * I (*q≥2020Q1)*			-54.863	-48.174
			(1.40)	(1.36)
Commercial and Industrial Loans *(t-i)* * I (q<2020Q1)	1.564***	-0.416***	1.929***	-0.644***
	(17.48)	(4.53)	(24.28)	(7.48)
Commercial and Industrial Loans *(t-i)* * I (q≥2020Q1)	0.736***	0.798***	1.120***	0.778***
	(6.42)	(5.59)	(10.57)	(6.40)
Bank Fixed effects	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes
R-Squared	0.131	0.152	0.278	0.257
No. of obs.	10,680	10,677	6,175	6,413

Table A3. Deposit Rates and Syndicated Loans

This table presents regressions of 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter syndicated loans. The CD rates are for accounts of $10k., $100k., and $500k. Independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Dependent Variables:					
	12-Month CD $10k rate		12-Month CD $100k rate		12-Month CD $500k rate	
	i=1	i=3	i=1	i=3	i=1	i=3
Syndicated Loans (t-i) × I *(q<2020Q1)*	0.0036***	0.0022*	0.0000	0.0026*	0.0000	0.0040**
	(2.96)	(1.68)	(0.07)	(1.85)	(1.12)	(2.49)
Syndicated Loans (*t-i*) × I (*q≥2020Q1)*	0.0042*	0.0022	0.0006	0.0034	0.0000	0.0041
	(1.76)	(1.02)	(0.24)	(1.41)	(0.46)	(1.33)
Bank Fixed Effects	Y	Y	Y	Y	Y	Y
Quarter Fixed Effects	Y	Y	Y	Y	Y	Y
R-squared	0.6888	0.6865	0.6579	0.659	0.66	0.6619
Observations	907	907	879	879	739	739

Table A4. Deposit Rates and Commercial and Industrial loans

This table presents regressions of 12-month Certificate of Deposit (CD) rate, and lagged quarter-on-quarter loan growth. The CD rates are for accounts of $10k., 100k., and $500k. Loan growth is defined as quarterly change in Commercial and Industrial (C&I) Loans. Panel B presents the results for banks with the lower size as measured by bank assets, using the bottom 10% decile. Panel B presents the results for banks with the higher size as measured by bank assets, using the top 10% decile. Independent variables are lagged by 1 quarter (i=1) and therefore for the pandemic period it reflects results after Q1 2020. Also, independent variables are lagged by 3 quarters (i=3) and therefore for the pandemic period it reflects results for Q1 2020 only. The sample is from January 2016 till December 2019 for the pre-pandemic period, and from January 2020 till December 2020 for the pandemic period. All regressions are ordinary least square regressions and have bank and quarter (time) fixed effects. Standard errors are double-clustered by bank and quarter. Inside the parentheses are the t-statistics. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Bottom 10% banks by size (assets)

	Dependent Variables					
	12-Month CD $10K rate		12-Month CD $100K rate		12-Month CD $500K rate	
	i=1	i=3	i=1	i=3	i=1	i=3
C&I loans growth (t-i) × I (q<2020Q1)	-9.740	-9.790	-10.500	-5.950	-11.20*	-12.10*
	(1.49)	(1.47)	(1.57)	(0.88)	(1.66)	(1.77)
C&I loans growth (t-i) × I (q>=2020Q1)	3.090	-5.700	-5.480	-28.50*	-45.60**	-5.90**
	(0.42)	(0.34)	(0.07)	(1.73)	(2.10)	(2.32)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.7170	0.7168	0.7179	0.7189	0.7346	0.7339
No. of obs.	6,446	6,441	6,117	6,115	5,501	5,505

Panel B. Top 10% banks by size (assets)

	Dependent Variables					
	12MCD10K rate		12MCD100K rate		12MCD500K rate	
	i=1	i=3	i=1	i=3	i=1	i=3
C&I loans growth (t-i) * I (q<2020Q1)	-0.0062	-0.0061	-0.0012	-0.0026	-0.0000	-0.0028
	(1.05)	(1.05)	(0.20)	(0.44)	(0.00)	(0.45)
C&I loans growth (t-i) * I (q>=2020Q1)	0.0035	0.0058*	-0.0033	0.0055*	0.0053	0.0036
	(1.20)	(1.79)	(1.13)	(1.65)	(1.19)	(0.45)
Bank Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.6781	0.6784	0.6733	0.6729	0.6999	0.6997
No. of obs.	8,616	8,609	8,531	8,526	7,284	7,280