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Do banks adjust their capital when they face liquidity shortages? Evidence from U.S. commercial banks

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Abstract:

We investigate how small and large banks behave when they face liquidity shortages. Our findings reveal that only small banks increase their capital ratios during episodes of liquidity shortages. They do so by downsizing but also by holding less risky assets and by reducing their lending. Furthermore, the increase in capital ratios is higher for small banks which are more reliant on market liquidity and small banks operating below their target capital ratio. On the whole, our findings show that small banks operate prudently whereas large banks are less concerned. Our work has strong implications for bank regulation and supervision.

JEL Classification: G21, G28

Keywords: bank capital ratio, market liquidity shortage, capital structure adjustment

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We investigate how small and large banks behave when they face liquidity shortages. Our findings reveal that only small banks increase their capital ratios during episodes of liquidity shortages. They do so by downsizing but also by holding less risky assets and by reducing their lending. Furthermore, the increase in capital ratios is higher for small banks which are more reliant on market liquidity and small banks operating below their target capital ratio. On the whole, our findings show that small banks operate prudently whereas large banks are less concerned. Our work has strong implications for bank regulation and supervision.

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1. Introduction

Holding enough capital allows banks to absorb losses, to be more solvent and therefore avoid bankruptcy. Capital requirements have hence become an essential tool to regulate banks by providing cushion during episodes of adverse financial conditions and by preventing banks from taking excessive risk *ex ante*. More specifically, during the global financial crisis of 2007-2009, systemic liquidity risk was a major contributor to bank failure as documented by Hong et al. 2014. Thus, while capital ratios are considered in the literature as an essential tool to reduce the risk of bank failure, systemic liquidity risk, which translates into a widespread market liquidity shortage, can also play a major role in triggering distress. Banks are therefore expected to take action during times of liquidity shortage by adjusting their balance sheets to improve their internal liquidity and namely their capital ratios to increase their financial strength. By making such adjustments they reassure their depositors, avoid higher funding costs and possibly avoid runs. Showing higher financial strength also allows them to more easily access funds on the market. All in all, when market liquidity dries up, banks may either downsize their overall activity to achieve lower leverage or substitute liquid assets to loans to improve their internal liquidity which also leads to an increase in regulatory capital ratios which are risk-weighted.

In this paper, we investigate how banks adjust their regulatory capital when they face sharper conditions to raise liquidity on the market by using a capital structure adjustment approach. Although there is an extent literature focusing on the determinants of bank capital structure adjustment (e.g. Niu et al., 2023; Bakkar et al., 2023; An et al., 2021; Gilani et al., 2021; Wojewodzki, et al., 2020; Mohammad and Nishiyama, 2019; Ghosh and Chatterjee, 2018; Cohen and Scatigna, 2016; De Jonghe and Öztekin, 2015; Lepetit et al., 2015; Öztekin and Flannery, 2012; Memmel and Raupach, 2010; Berger et al., 2008) and a literature focusing on the relationship between capital and bank liquidity (see e.g. Gupta et al., 2023; Patel et al., 2022; DeYoung et al., 2018; Castiglionesi et al., 2014; De Haan and Van Den End, 2013; Distinguin et al., 2013), how liquidity shortages affect the adjustment process remains an open question. We capture episodes of such market liquidity shortages by sudden and sharp increases in commercial paper rates and specifically the TED spread, i.e. the difference between the three-month LIBOR and the three-month T-bill interest rates by following Cornett et al. (2011), Wu and Hong (2012), Rodríguez-Moreno and Peña (2013) and Hong et al. (2014). We also consider spikes in the commercial paper spread (Gatev and Strahan, 2006).

To figure out the different channels by which market liquidity shortages may impact banks' capital structure adjustment, we distinctively investigate the effect of such shortages on three

aspects: first, on the share of risk weighted assets in total assets (substitution effect); second, on the share of loans in total assets (impact on lending) and third, on total assets (possible downsizing). We also account for banks' degree of reliance on market liquidity. Indeed, banks that hold lower liquid assets or with higher maturity mismatch between assets and liabilities may be differently affected by a liquidity shortage on the market than other banks. Their stronger reliance on market liquidity could urge them to take stronger actions to adjust their balance sheets. Moreover, banks operating below their target capital ratios might also behave differently than banks operating above their target. Such banks are expected to be under stronger pressure to adjust to their target. Eventually, because they are financially more constrained than large banks, small banks might also adjust differently. To go deeper we also look into the speed at which banks adjust.

The literature on the impact of market liquidity breakdowns on banks is scarce and the papers related to our study are far from being conclusive. Castiglionesi et al. (2014) show theoretically and empirically that banks facing undiversifiable liquidity risk, i.e. liquidity risk that banks cannot co-insure on interbank markets, tend to hold higher capital. In their setting banks less active on the interbank market hold higher capital. In a similar vein, Ritz and Walther (2015) theoretically document that increased uncertainty on funding conditions in money markets can explain various elements of commercial banks' behavior during the crisis, including the reductions in loan volumes and balance sheets, and raising additional equity capital from investors. Market liquidity, or the ability of a market to sell or buy an asset without affecting its price, and funding liquidity, which describes an entity's ability to obtain financing, are mutually reinforcing (see Brunnermeier and Pedersen, 2009; Chordia et al., 2000; Pástor and Stambaugh, 2003). Therefore, a shortage of liquidity in the market can negatively affect banks' balance sheets through the liquidity of their assets. Beladi et al. (2020) argue that borrowing banks reduce their holdings of risky assets when access to interbank funds is reduced. This would mechanically increase their total capital ratios. In addition, Acharya and Mora (2012) highlight that during the financial crisis of 2007-2009, illiquid banks attracted depositors by offering high interest rates on insured deposits. The increase in deposits consequently increases leverage, and banks would need to adjust their capital ratios to get closer to their target ratio. Meanwhile, Gatev and Strahan (2006) document a natural hedging behavior of banks against liquidity risk. They find that, during a liquidity disruption episode on the commercial paper market, bank deposits tend to grow. They argue that, during such episodes, because they are looking for a safe place, investors withdraw funds from markets and inject them into the banking system. However, such a behavior is challenged by other studies. For

instance, Pennacchi (2006) does not find any inflow of funds at banks during the pre-Federal Deposit Insurance Corporation (FDIC) period. This may be evidence that such inflows are caused by the government guarantees. Hence, the way that banks manage their capital in reaction to liquidity disruption is ambiguous. This is where this study comes in to shed light on how banks adjust their capital levels when faced with a liquidity shortage in the market.

In our investigation, we use U.S. commercial banks' data prior to the introduction of liquidity requirements by the Basel III accord and find only small banks to positively adjust their capital ratios when facing liquidity shortages on the market. Large banks neither increase nor decrease their capital ratios. Small banks positively adjust their capital ratios by reducing the share of loans in total assets, by decreasing the share of assets with higher risk weights and by downsizing their overall balance sheets. Our results also indicate that the extent to which small banks adjust their capital ratios when facing difficulties in accessing liquidity is not uniform. Less liquid small banks and small banks operating below their target capital ratios react more strongly than other small banks. Our further investigation shows that they also adjust faster under such circumstances. The upward adjustment is consistent with the “capital-liquidity substitutability” documented in DeYoung et al. (2018). That is, DeYoung et al. (2018) find that banks responding to a capital shock become more liquid, while our paper finds that banks responding to a liquidity shock become more solvent.

By investigating whether market liquidity shortages impact banks' capital structure adjustment, we contribute to both the capital structure adjustment literature and the banking literature. More specifically, we present empirical evidence that market liquidity shortage is an important determinant of bank capital structure adjustment. To our knowledge, this is the first paper that investigates such an issue which is of major importance for bank regulation. Our findings indicate that liquidity requirements imposed at the individual bank level as defined in Basel III might not be necessary for small banks but appear to be crucial for large banks. This is because small banks take action to improve their solvency when facing a liquidity shortage on the market, which is not the case of large banks. Indeed, unlike larger ones, small banks adjust their capital ratios upward during episodes of tight conditions on the liquidity market. This attitude improves their financial health by extending their ability to absorb losses and makes them more resilient to liquidity shocks. Regarding large banks, their lack of response to market liquidity shortage reveals the importance of jointly regulating both capital and liquidity. This is in line with the findings of Patel et al. (2022), showing a link between banks' liquidity provisions and capital, with alterations in liquidity indirectly impacting the capital structure of financial institutions. Liquidity emerges as an additional tool for shaping bank capital structure

beyond mere capital requirements. Consistently with the view of Diamond and Rajan (2005) and Gupta et al. (2023), they advocate that liquidity and capital should be jointly considered to promote financial stability.

The remainder of the paper is organized as follows. In section 2, we present our data and the methodology and section 3 discusses the results. Section 4 looks at further issues and section 5 provides robustness checks. Section 6 concludes.

2. Data and Methodology

2.1. Presentation of the sample

We obtain the data used in this study from two different sources. We extract data to compute our measures of market liquidity shortage and data on GDP from the federal reserve bank of St Louis². Data on balance sheets and income statements come from SNL Financial. We use a sample consisting of an unbalanced panel of quarterly data from 2000 to 2014 for U.S. commercial banks which includes 10053 banks making 438,608 bank-quarter observations. These banks are the ones that provide information on their total assets on at least one quarter in our investigation period and have a total capital ratio higher than the minimum level required by regulation (8%). We exclude banks with a total capital ratio under the minimum required level because they might behave differently than their peers and disturb our analysis. Such banks would obviously be under regulatory pressure to enhance their capital ratio. We also split our sample into two subsamples of small and large banks. Following the literature, we consider banks with total assets higher than \$1 billion to be large and small banks are those with total assets lower or equal to \$1 billion³. To deal with the issue of possible outliers, we winsorize our variables at the 2nd and 98th percentiles.

In this study, which examines banks' responses to liquidity shortages in the market, we limit our investigation to the period spanning from 2000 to 2014. This timeframe serves as a critical window that allows us to investigate how banks navigated and managed liquidity challenges prior to the introduction of the Basel III liquidity requirements. Our work thus provides insights on the pre-Basel III period, shedding light on the banking industry's inherent potential resilience and adaptability in times of market stress, unobstructed by the later implementation of liquidity

² See <http://research.stlouisfed.org/>

³ We also use thresholds of \$2 billion and \$5 billion instead of \$1 billion. In each case, banks are considered large, if their total assets are above these levels. Overall, the main results remain the same.

standards. Consequently, this study offers a distinct perspective on banks' liquidity management and responses in an environment where only capital regulation was in place.

2.2. Definition of variables

The purpose of this paper is to investigate if market liquidity shortages affect banks' capital structure adjustment and the channels through which capital ratios are affected.

2.2.1. Total capital ratio

Our main dependent variable is the total capital ratio. The total capital ratio is the sum of Tier 1 capital and Tier 2 capital divided by total risk weighted assets. Tier 1 capital is the bank's core capital. It includes equity and published reserves while Tier 2 capital mainly includes subordinated debt and undisclosed reserves. We also use the Tier 1 capital ratio as an alternative dependent variable for robustness checks.

2.2.2. Proxies of market liquidity shortage

We use two different interest spreads to proxy market liquidity shortage.

Firstly, we follow Hong et al. (2014), Rodríguez-Moreno and Peña (2013), Wu and Hong (2012) and Cornett et al. (2011) and use the TED spread. Cornett et al. (2011) use the TED spread to measure liquidity strains on the banking system while Wu and Hong (2012) and Hong et al. (2014) use it to measure systemic liquidity risk. Rodríguez-Moreno and Peña (2013) use it to, more broadly, proxy systemic risk. The TED spread is the difference between the three-month London Interbank Offered Rate (LIBOR) and the three-month Treasury bills rate. It is used as a gauge of financial health. LIBOR is the unsecured interest rate on interbank loans and allows to perceive liquidity constraints and stress on the interbank market while the Treasury bill rates provide information about changes in macroeconomic conditions and monetary policy. In addition, because during periods of stress only government securities are accepted as collateral, Treasury bill rates tend to decrease. Therefore, in addition to information on liquidity risk and credit risk, the TED spread reflects flight-to-quality effects⁴. Secondly, for robustness checks, we follow Gatev and Strahan (2006) and use the commercial paper spread. Gatev and Strahan (2006) use spikes in the commercial paper spread to measure financial market disruptions. The commercial paper spread is a spread between the three-month

⁴ When banks perceive a liquidity constraint in the market, their willingness to lend to each other decreases, which leads them to require a higher interest rate and thus the LIBOR increases. At such times, most banks prefer safe investments and therefore invest in Treasury bills, which leads to a fall in the Treasury bill rate. Thus, the spread between the LIBOR and Treasury bills widens.

commercial paper rate for highly rated (AA) non-financial borrowers and the three-month Treasury bills rate. Commercial paper is an unsecured, short-term debt instrument (up to 270 days of maturity) issued by investment-grade corporations.

Spikes in both proxies (TED spread and commercial paper spread) highlight liquidity disruptions in the market. We therefore create a dummy variable MLS_t based on either the TED spread or the commercial paper spread. The dummy variable is equal to one if the observation is above its 75th percentile throughout the entire sample period and zero otherwise. We assume that spikes beyond the 75th percentile underline liquidity disruptions on the market. To check for robustness, we also use alternative thresholds (the 90th percentile and the mean plus two times the standard deviation).

2.2.3. Extent of reliance on market liquidity

Banks that do not hold enough liquidity with respect to their exposure are dependent on the liquidity provided by the market. Hence, such banks might react more strongly to a liquidity shortage in the market⁵. Thus, during periods of such liquidity stress, banks that are dependent on the market because they have lower liquidity ratios, might behave differently than banks holding higher liquidity ratios because the latter are less reliant on the market. To gauge the extent to which banks are dependent on the market, we follow the Basel III principles and compute the Net Stable Funding Ratio (NSFR) using the weights defined in DeYoung and Jang (2016)⁶. The Net Stable Funding Ratio is a liquidity standard established in 2010 by the Committee on Banking Supervisory (BCBS) to strengthen bank stability. It is calculated by dividing the amount of available stable funding by the amount of required stable funding. It can be defined as the proportion of long-term assets funded by long term or stable funding. Fully implemented since January 2019, banks need to set this ratio at a minimum of 100% to maintain a stable funding profile enabling them to sustain a liquidity crisis. In our investigation, we assume that less liquid banks (more reliant on market liquidity) are those whose NSFR is below 100%. Therefore, to capture such banks, we define a dummy variable $Z_{i,t}$ that is equal to one if bank i has a NSFR lower than 100% at time t and zero if otherwise.

For robustness checks, we also use an alternative threshold for NSFR (10th percentile) and three alternative variables to proxy banks' liquidity level. We use the loans to core deposits ratio assuming that banks with more than 100% of this ratio, are more exposed to liquidity

⁵ Banks react to liquidity stress according to their own characteristics (Chen et al., 2021; Beladi et al., 2020; Cornett et al. 2011; Ritz and Walther, 2015).

⁶ see APPENDIX A for detailed components.

shortages on the market because they are more dependent on market liquidity since they are net borrowers in the interbank market (Ritz and Walther, 2015). We also use the liquid assets to total assets ratio and we assume that banks that are below the 25th percentile (12.85%) of this ratio, are less liquid banks. Finally, we account for the extent to which banks rely on wholesale funding. We use the proxy of reliance on wholesale funding defined in SNL Financial. This proxy is calculated by dividing the sum of total borrowings and brokered deposits by the sum of total borrowings and total deposits. It depicts the portion of a bank's total funds that are from wholesale sources. We assume that banks are strongly reliant on wholesale funding if they are above the 75th percentile (12.35%) of this proxy.

2.2.4. Banks' capital ratio target

When facing a market liquidity squeeze, banks operating below their target total capital ratio may take stronger action to increase their capital ratio than banks operating above their target ratio. We therefore account for whether a bank is below or above its target capital ratio.

We model the target capital ratio as a function of banks' observable characteristics (e.g. Bakkar et al., 2023; Gilani et al., 2021; De Jonghe and Öztekin, 2015; Lepetit et al. 2015; Gropp and Heider, 2010; Lemmon et al., 2008; Flannery and Rangan, 2006):

$$TCR_{i,t}^* = \beta X_{i,t-1} \quad (1)$$

where $TCR_{i,t}^*$ is the target total capital ratio; $X_{i,t-1}$ is a vector of variables that determine the target level of the total capital ratio. The vector includes a dummy for market liquidity shortage, a dummy for mergers and acquisitions, the GDP growth rate to account for macroeconomic factors that impact all banks, proxies for banks' performance (return on assets), credit risk (non-performing loans to total loans), liquidity (NSFR) and size (natural logarithm of total assets). β is the vector of coefficients of the variables included in $X_{i,t-1}$.

Banks cannot adjust their capital ratio instantaneously and need time to reach the target level. Thus, we build a partial adjustment framework to take the cost of adjustment into account:

$$\Delta TCR_{i,t} = \lambda(TCR_{i,t}^* - TCR_{i,t-1}) + \varepsilon_{i,t} \quad (2)$$

where λ is a scalar adjustment speed ($0 < \lambda < 1$) and $TCR_{i,t}^*$ is the target capital ratio of bank i at time t . Substituting equation (1) into equation (2) and rearranging give the following estimation model:

$$TCR_{i,t} = \lambda\beta X_{i,t-1} + (1 - \lambda)TCR_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

Equation (3) includes the lagged dependent variable. Nickell (1981) shows that the presence of the lag dependent variable generates correlation between the regressor and the error term which leads to a bias in the coefficient estimates, which will be inconsistent (Shim, 2012). To fix this problem, Arellano and Bond (1991), Anderson and Hsiao (1982) and Blundell and Bond (1998) propose General Method of Moment (GMM) estimation procedures. However, when the time dimension T is relatively large, the bias becomes insignificant (Roodman, 2006, 2009) and the standard estimation procedures are asymptotically valid (kiviet, 1995). For instance, when the time dimension T is greater than 30, Judson and Owen (1999) document that fixed effects estimators perform better than GMM estimators. Loutschina (2011) indicates that the bias becomes problematic when T falls below 15 time periods. Our investigation period stems from 2000Q1 to 2014Q4 making 60 time periods. Therefore, like other studies such as Kim and Sohn (2017) and Berrospide and Edge (2010), we use fixed effect estimations after performing Hausman tests which validate the use of fixed effects versus random effects. Finally, we cluster standard errors at the bank level (see APPENDIX B for results). We recover β by dividing $\widehat{\lambda\beta}$ by $\widehat{\lambda}$ and we recover $\widehat{\lambda}$ from $\widehat{1 - \lambda}$. We can then use equation (1) to compute the estimated target total capital ratio for each bank i at time t . We use the estimated target capital ratio to compute the capital ratio deviation as follows:

$$GAP_{i,t-1} = TCR_{i,t}^* - TCR_{i,t-1} \quad (4)$$

Banks operating below their target capital ratio are the ones with a positive gap. To capture such banks, we create a dummy variable that is equal to one if $GAP_{i,t-1} > 0$ and zero if otherwise. For robustness checks, we follow the same procedure to capture banks operating below the level of the Tier 1 capital ratio they target.

2.2.5. Descriptive statistics

Table 1 presents the definitions and descriptive statistics of all the variables used in this investigation. The TED spread and the commercial paper spread, on average over the sample period, are respectively 0.47% and 0.33% with relatively high standard deviations⁷. The lowest value of the total capital ratio in our sample is 9.84% and the lowest value of the estimated target total capital ratio is 8.73%, which is higher than the minimum regulatory requirement consistent with the fact that banks' targets include buffers to prevent them from falling below the threshold in case of negative shocks and possibly face regulatory sanctions. On average, the ratio of liquid assets to total assets is equal to 24.32% and the NSFR is around 84% which is below the 100% that banks need to comply with. On average, the loans to core deposits ratio and the portion of wholesale funding in total funding are 78.44% and 8.23% respectively. On average, banks grew in size during our investigation period. Their balance sheets are also dominated by risky assets. The mean of risk-weighted assets over total assets is 67.71%. The correlation matrix (Appendix C) does not indicate major collinearity issues.

[insert table 1, graph 1 & graph 2]

2.3. Empirical specifications

Since the aim of this study is to investigate whether market liquidity shortage impacts banks' capital structure adjustment, we use an adjustment model. We observe at time t , a change in bank i 's capital ratio and link it to a market liquidity shortage occurring at time $t-1$. The total capital ratio can be increased by increasing capital (numerator) and/or decreasing risk weighted assets (denominator). Increasing capital is costly during such stress episodes and may also be interpreted as a bad signal and generate a decrease in the bank's value⁸ (see Myers and Majluf, 1984). Hence, to figure out the different channels in which market liquidity shortage may impact U.S. commercial banks' total capital ratio, we study the effect of such shortage on 1) the change in the share of risk weighted assets in total assets; 2) the change in the share of loans in total assets and 3) the change in total assets. Banks can indeed increase their total capital ratio by changing the composition of their assets (to reduce the level of risk weighted assets),

⁷ See graph 1 and graph 2.

⁸ As suggested by an anonymous referee, we have also investigated the impact of market liquidity shortages on common equity and have not found any significant link.

selling assets or reducing loans (downsizing). The empirical specifications are therefore given by:

$$Y_{i,t} = \alpha_i + \xi_t + \varphi_1 MLS_{t-1} + \varphi_2 Z_{i,t-1} + \varphi_3 dummy_gap_{i,t-1} + \varphi_4 (Z_{i,t-1} * MLS_{t-1}) + \varphi U_{i,t-1} + \eta_{i,t} \quad (5)$$

$$Y_{i,t} = \gamma_i + \theta_t + \omega_1 MLS_{t-1} + \omega_2 Z_{i,t-1} + \omega_3 dummy_gap_{i,t-1} + \omega_4 (dummy_gap_{i,t-1} * MLS_{t-1}) + \omega U_{i,t-1} + \mu_{i,t} \quad (6)$$

where $Y_{i,t}$ is either the change in the total capital ratio, the change in the share of risk weighted assets in total assets, the change in the share of loans in total assets or the change in total assets; α_i and γ_i are individual bank fixed effects and ξ_t and θ_t are time fixed effects; MLS_{t-1} is a dummy variable that is equal to one if throughout the whole period, the TED spread is higher than its 75th percentile at time t-1 and zero if otherwise, $Z_{i,t-1}$ is a dummy variable that is equal to one if bank i is more reliant on market liquidity at time t-1 and zero if otherwise; $dummy_gap_{i,t-1}$ is a dummy variable equal to one if $GAP_{i,t-1} > 0$ and zero if otherwise; $U_{i,t-1}$ is a vector of bank specific variables for bank i at time $t-1$. It includes the GDP growth rate to capture the business cycle, bank size proxied by the natural logarithm of total assets, the return on assets to account for banks' performance, the ratio of non-performing loans to total loans to measure risk in the bank's loan portfolio and a dummy to control for the effect of mergers and acquisitions. This dummy variable is equal to one if a bank's total assets grow by less than 10% during a given quarter and zero if otherwise.

Equation (5) allows investigating the influence of market liquidity shortages conditional to banks' degree of reliance on market liquidity while equation (6) allows to capture such an influence conditional to the gap between a bank's actual and target capital.

Thus, φ_1 , the coefficient of MLS_{t-1} in equation (5) captures the impact of market liquidity shortages on the dependent variable for banks less reliant on market liquidity. We expect this coefficient to be either non-significant or significant and positive. Indeed, to the extent that their bank holds more liquidity or is less exposed to maturity transformation risk, managers may not feel concerned about the shortage of liquidity in the market, and, therefore, may not take steps to adjust their total capital ratio and balance sheets more generally. In that case, φ_1 will be non-significant. However, if these managers are very cautious, they may

increase their total capital ratio. In that case, φ_1 is expected to be positive and significant when the dependent variable is the change in the total capital ratio.

The coefficient of MLS_{t-1} in equation (6), ω_1 , gives the impact of market liquidity shortages on the dependent variable for banks operating above their target capital ratio. We also expect it to be either non-significant or significant and positive. Indeed, the managers of banks operating above their target capital ratio may not adjust their capital ratio and balance sheet because they might feel safe and already well capitalized. In that case ω_1 will be non-significant. However, if the managers of such banks are very cautious, they may adjust their capital ratio positively. In that case, ω_1 is expected to be positive and significant when the dependent variable is the change in the total capital ratio.

The coefficients of $Z_{i,t-1}$ in both equations, φ_2 and ω_2 , capture the impact on the dependent variable of banks' reliance on market liquidity in the absence of a market liquidity shortage. These coefficients are expected to be positive, when the dependent variable is the change in the total capital ratio, because stronger reliance on market liquidity leads banks to increase their capital ratio to exhibit higher solvency to more easily borrow from the market. As documented by DeYoung et al. (2018), U.S. commercial banks treat liquidity and regulatory capital as substitutes. Distinguin et al. (2013) also find that small U.S. banks increase their regulatory capital ratios when they are exposed to higher illiquidity.

In both equations, the coefficients of $dummy_gap_{i,t-1}$, φ_3 and ω_3 , capture the impact of operating below the target capital ratio on the dependent variable in the absence of market liquidity shortage. We expect them to be positive and significant, when the dependent variable is the change in the total capital ratio, because banks operating below their target capital ratio, are expected to increase their capital ratio to get closer to their target.

φ_4 , the coefficient of the interaction term $Z_{i,t-1} * MLS_{t-1}$, captures the additional impact of market liquidity shortage on the dependent variable for banks more reliant on market liquidity compared to less reliant ones. We expect it to be positive and significant, when the dependent variable is the change in the total capital ratio, because banks more reliant on market liquidity should more extensively increase their capital ratio than their less market-reliant peers. Similarly, ω_4 , the coefficient of $dummy_gap_{i,t-1} * MLS_{t-1}$, gives the additional impact of market liquidity shortage on the dependent variable of banks operating below their target capital ratio compared to those operating above their target ratio. We also expect it to be positive and significant, when the dependent variable is the change in the total capital ratio, because banks

below their target capital ratio will react more promptly and to a larger extent. Consistently, we also expect $(\varphi_1 + \varphi_4)$ and $(\omega_1 + \omega_4)$ to be significantly positive.

3. Results

In this paper, we investigate the impact of market liquidity shortage on banks' capital structure adjustment and the channels through which the total capital ratio is impacted. Since our investigation period is 2000-2014, our results may be influenced by the global financial crisis of 2007-2008⁹ and government interventions¹⁰ during the crisis. The results can also be impacted by the 2000 dot-com crash. Therefore, in addition to estimating our regressions on the whole investigation period, we also conduct estimations by excluding both crisis periods (2000q1 to 2000q4 and 2007q3 to 2009q2). To exclude both crises, we construct our proxy of market liquidity shortage by using the 75th percentile of the TED spread throughout normal times only. This is to make sure that our proxy is not reflecting episodes of financial distress more generally and also that the liquidity shortage captured by this proxy is not itself driven by major factors. Tables 2 and 3 give the results on the whole investigation period and tables 4 and 5 give the results after excluding the two crisis periods. We use the fixed-effect method¹¹ and cluster standard errors at the bank level.

Overall, we find that market liquidity shortage does not impact the change in the total capital ratio of large banks, regardless of how much they rely on market liquidity or how far they are below their target capital ratio (φ_1 , ω_1 , $(\varphi_1 + \varphi_4)$ and $(\omega_1 + \omega_4)$ are not significant for large banks in ΔTCR equations). However, the results show that small banks respond to market liquidity shortage by positively adjusting their total capital ratio¹². Such banks do so by

⁹ Solvency issues associated with subprime loan defaults, mortgage foreclosures and downgrades of asset-backed securities that occurred during the crisis, led to significant capital losses and thus forced banks to restore their capital ratios.

¹⁰ The U.S. Treasury made approximately \$220 billions of capital injections through the Capital Purchase Program. The Federal Reserve implemented several facilities to provide significant amounts of liquidity to the banking system. These facilities include the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF), the commercial Paper Funding Facility (CPFF), the Money Market Investor Funding Facility (MMIFF), the Term Securities Lending Facility (TSLF) and the Primary Dealer Credit Facility (PDCF).

¹¹ We perform Hausman tests which validate the use of fixed effects versus random effects.

¹² In Appendix B, the negative sign of the MLS coefficient would indicate that the capital ratio level targeted by banks decreases during episodes of market liquidity shortage. Indeed, bank managers might revise the level of the capital ratio they target due to constraints during episodes of liquidity shortage. During such episodes, certain level of capital ratio might be hardly achievable. Bank managers could hence lower the level of their target capital ratio for an achievable level. However, this would not prevent them from adjusting their capital ratio upwards.

decreasing the share of risk weighted assets in total assets, by reducing the share of loans in total assets and by downsizing their balance sheets¹³.

Furthermore, the impact on the total capital ratio is stronger for small banks that are more reliant on market liquidity ($(\varphi_1 + \varphi_4) > \varphi_1$) in the ΔTCR equation). They also reduce the share of risk weighted assets in total assets by a larger extent and cut loans more extensively than small banks which are less reliant on market liquidity ($(\varphi_1 + \varphi_4) < \varphi_1$) in $\Delta LOANS$ equation and ΔRWA equation). Similarly, small banks operating below their target total capital ratio¹⁴ increase their total capital ratio more significantly than their peers operating above their target ratio ($(\omega_1 + \omega_4) > \omega_1$ in ΔTCR equation). They also tend to reduce their risk weighted assets (and hence their loans¹⁵) to a larger extent than small banks operating above their target total capital ratio ($(\omega_1 + \omega_4) < \omega_1$) in $\Delta LOANS$ equation and ΔRWA equation).

Our results are also economically meaningful. For example, considering the results on the whole investigation period, for small banks less reliant on market liquidity, a one-standard deviation increase in MLS increases ΔTCR by 0.263 which takes the mean from -0.150 to +0.113. A one-standard deviation increase in MLS also takes the mean of $\Delta LOAN$ from +0.11 to -0.346 and the mean of ΔRWA from +0.09 to -0.332. These changes are more important for banks more reliant on market liquidity. A one-standard deviation increase in MLS leads to a variation of the mean of ΔTCR from -0.150 to +0.285, to a variation of the mean of $\Delta LOAN$ from +0.11 to -0.58 and to a variation of the mean of ΔRWA from +0.09 to -0.621.

¹³ In the ΔTCR , $\Delta LOANS$, and $\Delta ASSET$ equations, the coefficients associated to market liquidity shortage in tables 4 and 5 displaying the effect of such shortage during non-crisis period are, in absolute value, higher than the ones in tables 2 and 3 showing the results for the overall period. However, we cannot conclude that there is a much higher effect of market liquidity shortage during the non-crisis period. Indeed, we cannot make a direct comparison between these coefficients since they are from two different equations with different number of observations (since the time dimensions are different). Similarly, we do not make a direct comparison between large and small banks.

¹⁴ Regardless the size of banks, φ_3 and ω_3 are found to be positive and significant in ΔTCR equations and $\Delta ASSET$ equations while they are negative and significant in $\Delta LOANS$ equations and ΔRWA equations. These results indicate that, in the absence of market liquidity shortages, operating below the target capital ratio leads U.S. commercial banks to increase the total capital ratio by reducing their share of risk-weighted assets (loans) in total assets. They also increase the size of their balance sheet. This increase combined with the reduction in the share of risk-weighted assets suggests that banks replace risky assets with safer assets in the process of adjusting their total capital ratio. Moreover, φ_2 and ω_2 are significant in ΔTCR equations only for small banks. Thus, in the absence of market liquidity shortages, greater reliance on market liquidity leads only small banks to increase their capital ratio to exhibit greater solvency in order to borrow more easily from the market. They do this by reducing their lending and the share of risk-weighted assets on their balance sheet (φ_2 and ω_2 are significant and negative in $\Delta LOANS$ equations and ΔRWA equations).

¹⁵ As argued by an anonymous referee, to lower their risk exposure in times of market liquidity shortages, additionally to reducing their risk-weighted assets by cutting loans, banks could also reallocate their trading portfolio or reduce its size. The results, available on request, show that banks do not increase the share of treasuries (safe assets) or reduce the share of the trading portfolio in total assets when facing difficulties to raise liquidity on the market.

For small banks operating above their target capital ratio, a one-standard deviation increase in MLS increases ΔTCR by +0.321 and this change is more important for banks operating below their target capital ratio (+0.471). A one-standard deviation increase in MLS leads, for banks operating above their target capital ratio, to a mean of $\Delta LOAN$ and ΔRWA equal to -0.435 and -0.418 respectively. These changes are also larger for banks operating below their target capital ratio (-0.597 and -0.713 for $\Delta LOAN$ and ΔRWA respectively).

On the whole, these results¹⁶ show that only small banks react to liquidity squeeze by adjusting their balance sheets¹⁷ and by downsizing and cutting lending¹⁸ which enhances their total capital ratio. Nevertheless, this capital ratio improvement is stronger for small banks more reliant on market liquidity and small banks operating below their target capital ratio.

Small banks may be adjusting their capital ratio positively because their confidence in the market decreases and/or they need to show stronger financial strength or hedge against possible losses (Ramos, 1996). They might also behave as such for precautionary reasons to avoid falling under the minimum regulatory level of the capital ratio. By reducing their default risk (higher capital ratio), banks could also be aiming to avoid a higher cost of uninsured deposits by limiting the higher premium required by depositors (Fonseca and González, 2009) or the likelihood of a bank run (Dermine, 2015). Most strikingly, small banks are the only ones to behave as such. Large banks' capital ratios do not at all react to liquidity shortages possibly because they have easier access to fed funds under any circumstances and because their "too-big-to-fail" status enables them to benefit from government support which is not the case for small banks (Sorkin, 2009; Brewer and Jagtiani, 2011; Bloomberg View's Editorials, 2013). They might also have access to a broader range of funding sources or more diversified portfolios, which could help them manage liquidity constraints without significant adjustments to their capital structure. The behavior adopted by small banks is consistent with the "capital-liquidity substitutability" documented in DeYoung et al. (2018) that show that banks reacting

¹⁶ The dummy variable for merger and acquisition is constructed by giving the value of 1 when the asset growth rate is lower than 10%. Hence, the negative association between the dummy variable and the assets ratio ($\Delta ASSETS$) means that banks with asset growth lower than 10% have a lower level of assets ratio. Similarly, banks with asset growth rate higher than 10% have a higher level of assets ratio. As to the coefficients of GDP growth, since the dependent variable in the $\Delta LOANS$ equation is the change in the share of loans in total assets the positive sign of the GDP growth coefficient means that loans are gaining importance in total assets. This can be due to either an increase in loans and/or a fall in total assets.

¹⁷ As an anonymous referee suggested, since market liquidity shortage decreases the size of the balance sheet, it would be important to know what goes down on the liability side. The results, available upon request, show that banks reduce their deposit funding.

¹⁸ These results are in line with the literature that underlines the negative effect of liquidity shocks on balance sheet (Ritz and Walther, 2015) and on bank lending (Dombret et al. (2018), Chouchène et al. (2017), Allen et al. (2014), Calem et al. (2013), De Haas and Van Horen (2013), Schnabl (2012), Puri et al. (2011), Cornett et al. (2011), Ivashina and Scharfstein (2010), Peek and Rosengren (1997)).

to a capital shock become more liquid, whereas our results show that banks that respond to a liquidity shock become more solvent.

[insert tables 2,3, 4 & table 5]

4. Further issue: small banks' capital ratio adjustment speed during market liquidity shortage episodes

Our results show that market liquidity shortage leads small banks to positively adjust their total capital ratio. In this sub-section, we investigate the speed with which such banks adjust their total capital ratio during a period of market liquidity shortage. We express the adjustment speed as follows (e.g. Gilani et al., 2021; Öztekin and Flannery, 2012; DeYoung et al., 2018):

$$\lambda_{i,t} = AV_{i,t-1} \quad (9)$$

Where $\lambda_{i,t}$ is the bank-specific, time-varying adjustment speed toward the target capital ratio; $V_{i,t-1}$ is a vector of bank and time period characteristics that affect the speed of adjustment. It includes a dummy variable equal to one if the bank has a NSFR lower than 100% or 0 if otherwise; a dummy variable equal to one if the bank is operating below its target total capital ratio or 0 otherwise and the ratio of non-performing loans to total loans. A is a vector of coefficients to be estimated. Substituting equation (9) into (2) yields the following equation:

$$\Delta TCR_{i,t} = AV_{i,t-1}(TCR_{i,t}^* - TCR_{i,t-1}) + \varepsilon_{i,t} \quad (10)$$

Rewriting equation (10) and using equation (4) yields:

$$\Delta TCR_{i,t} = AV_{i,t-1}GAP_{i,t-1} + \varepsilon_{i,t} \quad (11)$$

We account for bank fixed effects and quarterly time fixed effects and we estimate equation (11) using ordinary least squares¹⁹.

The results (see appendix D) show that during times of market liquidity shortage, small banks more reliant on market liquidity adjust faster than small less reliant banks. Small banks operating below their target total capital ratio also adjust faster than small banks operating above their target total capital ratio. We find that the speed of adjustment of small banks more

¹⁹ We follow Öztekin and Flannery (2012) and DeYoung et al. (2018).

reliant on market liquidity is 0.0675% faster than the speed of adjustment of small banks less reliant on market liquidity and the adjustment speed of banks operating below their target capital ratio is 0.126% faster than at banks operating above their target capital ratio.

5. Robustness checks

We perform several robustness checks²⁰. First, in our baseline regression, we consider a bank to be relatively less liquid if its NSFR is lower than 100%. However, because the NSFR was introduced in the Basel III accords in 2010 and because banks were supposed to gradually come into compliance with these requirements from 2015 to 2019, we take a lower threshold because banks might not have considered falling below 100% as a threat. We assume that less liquid banks are the ones whose NSFR is lower than the 10th percentile of NSFR (27.92%). The obtained results are consistent with those of the severe market liquidity shortage case and the baseline regression.

In addition, we use alternative variables to NSFR to measure banks' liquidity level. These alternative variables are i/ reliance on wholesale funding, ii/ total liquid assets to total assets ratio and iii/ loans to core deposits ratio²¹. The obtained results are in line with our main results.

We also limit our sample to banks that are strongly focused on intermediation activities that we name “real commercial banks” by only including banks with total deposits to total assets ratio and total loans over total assets higher than 30%. These banks are more exposed to liquidity risk since liquidity risk mostly emanates from exposures linked to intermediation activities (undrawn loan commitments, demand deposits, withdrawal of funds from wholesale deposits...). Considering this restricted sample of “real commercial banks”, our findings remain unchanged.

In the main regressions, to capture market liquidity shortages, we use a dummy variable equal to one if the TED spread is higher than its 75th percentile. Now, instead of the 75th percentile we consider more restrictive conditions to capture severe cases of liquidity shortage on the market: 90th percentile and the mean plus two times the standard deviation. The results found are consistent with our main results.

Our results indicate that large banks do not adjust their total capital ratio during periods of high pressure on the liquidity market. Therefore, we look deeper and investigate whether their

²⁰ We omit reporting the results of robustness checks in order to shorten and rationalize the Appendixes and save on space as suggested by the referee, but they are available upon request.

²¹ See table 1 for variables definitions.

behavior can be explained by differences in risk management sophistication. Large banks with sophisticated risk management tools may not increase their total capital ratio because they can more easily cope with such shortage episodes while those with poorer risk management tools might positively react²². As a proxy of risk management sophistication, we use the notional value of the interest rate swap and futures contracts committing the reporting institution to purchase or sell equity securities. We use these instruments because the former allows banks to manage risk more effectively, hedge potential losses and improve cash flow while the latter may allow banks to raise capital in public and private markets. We consider that banks above the median of these variables have better risk management practices (median equals 0). We find similar results for all type of large banks. Large banks with a better risk management technology do not behave differently than their less sophisticated peers.

In addition, we check if our results are robust to various definitions of the capital ratio. Instead of the total capital ratio we use the Tier 1 capital ratio. Tier 1 capital represents a bank's core capital. The obtained results are consistent with our main results. In addition, we estimate the target Tier 1 capital ratio ($TIER_ONE_{i,t}^*$) for each bank i at time t . We use the estimated target Tier 1 capital ratio to compute the deviation as:

$$GAP_TIER_{i,t-1} = TIER_ONE_{i,t}^* - TIER_ONE_{i,t-1} \quad (12)$$

We then isolate banks operating below their target Tier 1 capital ratio and perform estimations to check if our results found for banks operating below (above) their target total capital ratio are robust. Again, our main findings remain unchanged.

Finally, instead of the TED spread, we use the commercial paper spread to proxy market liquidity shortage. Our results remain unchanged.

6. Conclusion

Using an unbalanced panel database of U.S. commercial banks, we investigate the influence of episodes of liquidity squeeze on the market on their capital ratios and balance sheet adjustments. We specifically focus on the different channels that affect their total capital ratio. We also account for size, reliance on market liquidity and gap between banks' actual and target capital ratios. Overall, our findings highlight that only small banks react to market liquidity

²² Large banks are known to use more sophisticated management tools specifically in exploiting hard information whereas small banks rely more on soft information (Stein, 2002) which can also be very efficient but strictly limited to traditional lending activities. Banks with sophisticated risk management tools are expected to better handle overall risk (not strictly limited to borrowers' default) and hence may not respond to a shock like banks with less sophisticated risk management tools.

shortage by increasing their total capital ratio. To improve their capital ratio, small banks downsize, cut lending and reduce their share of risk weighted assets in total assets. This improvement in the capital ratio is stronger at small banks more reliant on market liquidity and small banks operating below their target capital ratio.

To hedge against tighter liquidity conditions on the market, banks can either hold more liquidity or hold more capital which would allow them to more easily borrow on the market. Our results hence suggest that liquidity requirements, as defined in Basel III, might be redundant for small banks unlike for larger ones which do not take measures to improve their solvency standards during episodes of liquidity shortage on the market, whether highly or moderately dependent on market liquidity. This paper therefore provides only limited support for the liquidity standards defined in Basel III. These standards would have a limited beneficial effect on the stability of small U.S. commercial banks. However, this paper supports these reforms for large banks because they could enable such banks to better respond to liquidity crises.

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Table 1: Definition of variables and descriptive statistics

Variables	definitions	Obs	Mean	Std. Dev.	Min	Max
<u>Dependent variables</u>						
tcr (%)	total capital ratio	438,608	18.05	10.20	9.84	67.25
Δ tcr	quarterly change in total capital ratio	428,507	-0.15	2.24	-57.41	57.41
rwa (%)	risk weighted assets as a percent of total assets	434,251	67.71	13.97	26	98.67
Δ rwa	quarterly change in risk weighted assets to total assets ratio	424,181	0.09	4.01	-72.67	72.67
loan_a (%)	total loans to total assets ratio	434,257	62.49	16.17	19.30	88.14
Δ loan	quarterly change in total loans to total assets ratio	424,224	0.11	3.83	-68.84	68.84
Δ asset (%)	quarterly change in total assets divided by total assets	428,546	1.85	5.42	-11.88	26.13
Tier one (%)	Tier one capital ratio	438,410	16.79	10.06	7.95	64.68
Δ tier	quarterly change in Tier 1 ratio	428,309	-0.15	2.18	-56.40	56.73
<u>Market liquidity shortages proxies</u>						
TED spread (%)	the difference between the three-month London Interbank Offered Rate (LIBOR) and the three-month Treasury bills rate	438,608	0.47	0.42	0.15	2.45
MLS_ted	dummy equal to one if the TED spread is higher than its 75 th percentile or zero otherwise**	438,608	0.25	0.43	0	1
commercial paper spread (%)	the spread between the three-month commercial paper rate for highly rated (AA) non-financial borrowers and the three-month Treasury bills rate.	438,608	0.33	0.39	0.07	2.28
MLS_cp	dummy equal to one if the commercial paper spread is higher than its 75 th percentile or zero otherwise**	438,608	0.27	0.44	0	1
<u>Extent on market liquidity proxies</u>						
NSFR (%)	Net Stable Funding Ratio (see Appendix A)	277,247	84.39	50.07	9.16	224.59
Z_nsfr	dummy equal to one if the NSFR<100% or zero otherwise**	277,247	0.63	0.48	0	1
rwf (%)	reliance on wholesale funding, it depicts the portion of a bank's total funds that are from wholesale sources. (total borrowings + brokered deposits) / (total borrowings + total deposits).	431,331	8.23	10	0	40.62
Z_rwf	dummy equal to one if rwf is higher than its 75 th percentile or zero otherwise	431,331	0.25	0.43	0	1
LTCD (%)	loans to core deposits ratio	429,942	78.44	32.42	7.03	238.75
Z_LTCD	dummy equal to one if LTCD> 100% or zero otherwise	429,942	0.16	0.37	0	1
liquid_a (%)	assets that can quickly be turned into cash without an important loss as a percentage of total assets. liquid assets are calculated as the sum of cash and balances due, federal funds sold and securities purchased under agreements to resell, total securities, and total trading account assets less the value of total pledged securities	438,599	24.32	15.69	2.81	81.47

Z_liq	dummy equal to one if liquid_a is lower than its 25 th percentile or zero otherwise	438,599	0.25	0.43	0	1
<u>Variables for bank's capital position</u>						
tcr* (%)	The estimated target total capital ratio	267,039	13.93	1.48	8.73	18.09
dummy_gap	dummy equal to one if the bank is operating below its target capital ratio	267,039	0.43	0.49	0	1
Tier 1* (%)	The estimated target Tier 1 capital ratio	267,039	13.10	1.43	7.96	17.03
dummy_gap_one	dummy equal to one if the bank is operating below its target Tier one capital ratio	267,039	0.46	0.50	0	1
<u>Control variables</u>						
size	the natural logarithm of total assets	438,608	18.72	1.37	11.13	28.36
ROA (%)	return on assets	430,748	0.83	1.40	-6.75	5.02
NPL (%)	non-performing loans over total loans	425,972	1.58	2.51	0	14.36
GDP growth (%)	quarterly growth rate of GDP	438,608	0.97	0.73	-1.97	2.47
M&A	dummy for mergers and acquisitions. Dummy equal to one if the asset growth rate is lower than 10% during the quarter and zero otherwise.	428,546	0.93	0.26	0	1
<u>Other variables</u>						
depo_a (%)	total deposits to total assets ratio	434,208	81.93	12.37	2.21	92.98
nvswp	the notional value of interest rate swap (in thousands of USD)	277,249	8423916	4.97E+08	0	5.45E+10
eqfu	futures contracts committing the reporting institution to purchase or to sell equity securities or instruments based on equity indexes such as the standard and poor's 500, or the nikkei (in thousands of USD)	277,249	6262.70	468267	0	8.24E+07

**in robustness checks, we use alternative thresholds.

TABLE 2: Impact of market liquidity shortages according to bank liquidity level

This table displays the impact of market liquidity shortages on the change in total capital ratio (ΔTCR), on the change in asset share of risk weighted assets (ΔRWA), on the change in asset share of total loans ($\Delta LOAN$) and on the change in total assets ($\Delta ASSET$) according to whether or not the bank is more reliant on market liquidity. MLS_{t-1} is a dummy variable that is equal to one if the TED spread is higher than its 75th percentile at time t-1. $Z_{i,t-1}$ is a dummy variable that is equal to one if bank i is more reliant on market liquidity (NSFR<100%) at time t-1 or 0 otherwise. size is the natural logarithm of total assets. ROA is return on asset. NPL is non-performing loans over total loans. Dummy_gap is a dummy variable equals to one if the bank is operating below its target total capital ratio ($GAP_{i,t-1} > 0$) or 0 otherwise. GDP growth is the quarterly growth rate of GDP. M&A is a dummy variable for mergers and acquisitions. It is equal to one if the asset growth rate is lower than 10% during the quarter and zero otherwise. “large” corresponds to banks with total assets higher than \$1 billion and “small” corresponds to banks with total assets lower or equal to \$1 billion. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level.

	ΔTCR		ΔRWA		$\Delta LOAN$		$\Delta ASSET$	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
$MLS_{t-1} (\varphi_1)$	-0.578 (0.580)	0.263*** (0.0973)	1.501* (0.793)	-0.422*** (0.157)	-0.159 (0.818)	-0.456*** (0.152)	0.187 (0.683)	-0.430** (0.172)
$Z_{i,t-1} (\varphi_2)$	0.103 (0.166)	0.0685*** (0.0137)	-0.137 (0.212)	-0.142*** (0.0238)	-0.530** (0.259)	-0.270*** (0.0244)	0.0816 (0.206)	0.0198 (0.0255)
$dummy_gap_{i,t-1} (\varphi_3)$	0.597*** (0.0965)	0.414*** (0.0154)	-0.860*** (0.128)	-0.931*** (0.0308)	-0.380** (0.168)	-0.475*** (0.0276)	0.456*** (0.139)	0.193*** (0.0290)
$Z_{i,t-1} * MLS_{t-1} (\varphi_4)$	0.191 (0.155)	0.173*** (0.0244)	-0.495 (0.364)	-0.290*** (0.0427)	-0.0516 (0.393)	-0.234*** (0.0397)	-0.142 (0.344)	0.0345 (0.0394)
Size $_{i,t-1}$	0.105 (0.273)	1.066*** (0.0552)	0.286 (0.370)	-0.961*** (0.0675)	-0.412 (0.325)	-1.324*** (0.0760)	-2.360*** (0.247)	-2.310*** (0.0853)
ROA $_{i,t-1}$	0.221*** (0.0360)	0.379*** (0.0115)	-0.0235 (0.0464)	-0.204*** (0.0166)	-0.137** (0.0533)	-0.326*** (0.0172)	0.273*** (0.0490)	0.184*** (0.0137)
NPL $_{i,t-1}$	0.0532** (0.0213)	0.0924*** (0.00384)	-0.102*** (0.0264)	-0.144*** (0.00611)	-0.138*** (0.0330)	-0.196*** (0.00660)	-0.243*** (0.0394)	-0.296*** (0.00745)
GDP growth $_{t-1}$	0.267 (0.307)	0.137** (0.0544)	0.0269 (0.297)	0.459*** (0.0933)	0.0829 (0.372)	0.506*** (0.0915)	-1.174*** (0.270)	-0.809*** (0.0989)
$M\&A_{i,t-1}$	0.904*** (0.111)	1.407*** (0.0392)	3.036*** (0.210)	3.245*** (0.0676)	2.175*** (0.245)	3.611*** (0.0777)	-15.36*** (0.267)	-13.11*** (0.0805)
Banks fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
$\varphi_1 + \varphi_4$	-0.387	0.435	1.006	-0.711	-0.211	-0.690	0.0457	-0.396
Wald test p value	0.493	0.000	0.147	0.000	0.766	0.000	0.939	0.021
r2	0.0770	0.210	0.116	0.0895	0.0760	0.130	0.625	0.542
N	17408	249459	17181	248520	17181	248527	17408	249459

TABLE 3: Impact of market liquidity shortages according to gap between actual and target capital

This table displays the impact of market liquidity shortages on the change in total capital ratio (ΔTCR), on the change in asset share of risk weighted assets (ΔRWA), on the change in asset share of total loans ($\Delta LOAN$) and on the change in total assets ($\Delta ASSET$) according to whether or not the bank is operating below its target total capital ratio. MLS_{t-1} is a dummy variable that is equal to one if the TED spread is higher than its 75th percentile at time t-1. $Z_{i,t-1}$ is a dummy variable that is equal to one if bank i is more reliant on market liquidity (NSFR<100%) at time t-1 or 0 otherwise. size is the natural logarithm of total assets. ROA is return on asset. NPL is non-performing loans over total loans. Dummy_gap is a dummy variable equals to one if the bank is operating below its target total capital ratio ($GAP_{i,t-1} > 0$) or 0 otherwise. GDP growth is the quarterly growth rate of GDP. M&A is a dummy variable for mergers and acquisitions. It is equal to one if the asset growth rate is lower than 10% during the quarter and zero otherwise. “large” corresponds to banks with total assets higher than \$1 billion and “small” corresponds to banks with total assets lower or equal to \$1 billion. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level.

	ΔTCR		ΔRWA		$\Delta LOAN$		$\Delta ASSET$	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
$MLS_{t-1} (\omega_1)$	-0.630 (0.569)	0.321*** (0.0962)	1.206* (0.676)	-0.508*** (0.155)	-0.160 (0.710)	-0.545*** (0.150)	0.0189 (0.633)	-0.414** (0.171)
$Z_{i,t-1} (\omega_2)$	0.140 (0.156)	0.111*** (0.0129)	-0.237 (0.204)	-0.214*** (0.0226)	-0.541** (0.242)	-0.328*** (0.0233)	0.0524 (0.185)	0.0284 (0.0237)
$dummy_gap_{i,t-1} (\omega_3)$	0.532*** (0.107)	0.378*** (0.0162)	-0.819*** (0.145)	-0.861*** (0.0317)	-0.366** (0.169)	-0.436*** (0.0288)	0.443*** (0.146)	0.191*** (0.0303)
$dummy_gap_{i,t-1} * MLS_{t-1} (\omega_4)$	0.289* (0.159)	0.150*** (0.0179)	-0.190 (0.260)	-0.295*** (0.0368)	-0.0588 (0.278)	-0.162*** (0.0339)	0.0552 (0.245)	0.00937 (0.0381)
Size $i,t-1$	0.106 (0.275)	1.067*** (0.0552)	0.288 (0.371)	-0.962*** (0.0675)	-0.412 (0.326)	-1.328*** (0.0760)	-2.359*** (0.247)	-2.309*** (0.0854)
ROA $i,t-1$	0.221*** (0.0358)	0.379*** (0.0115)	-0.0225 (0.0464)	-0.204*** (0.0166)	-0.137** (0.0533)	-0.326*** (0.0172)	0.274*** (0.0490)	0.184*** (0.0137)
NPL $i,t-1$	0.0525** (0.0214)	0.0917*** (0.00383)	-0.102*** (0.0265)	-0.143*** (0.00607)	-0.138*** (0.0331)	-0.195*** (0.00659)	-0.243*** (0.0395)	-0.296*** (0.00745)
GDP growth $t-1$	0.267 (0.307)	0.137** (0.0544)	0.0272 (0.296)	0.458*** (0.0933)	0.0828 (0.372)	0.506*** (0.0915)	-1.173*** (0.270)	-0.809*** (0.0989)
$M\&A_{i,t-1}$	0.904*** (0.111)	1.407*** (0.0391)	3.034*** (0.210)	3.245*** (0.0676)	2.175*** (0.245)	3.611*** (0.0777)	-15.36*** (0.267)	-13.11*** (0.0805)
Banks fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
$\omega_1 + \omega_4$	-0.341	0.471	1.017	-0.803	-0.219	-0.707	0.0740	-0.404
Wald test p value	0.549	0.000	0.154	0.000	0.763	0.000	0.902	0.019
r2	0.0774	0.210	0.116	0.0895	0.0760	0.130	0.625	0.542
N	17408	249459	17181	248520	17181	248527	17408	249459

TABLE 4: Impact of market liquidity shortages according to bank liquidity level during non-crisis period

This table displays during non-crisis period, the impact of market liquidity shortages on the change in total capital ratio (ΔTCR), on the change in asset share of risk weighted assets (ΔRWA), on the change in asset share of total loans ($\Delta LOAN$) and on the change in total assets ($\Delta ASSET$) according to whether or not the bank is more reliant on market liquidity. We exclude the crisis periods (2007q3 to 2009q2 and 2000q1 to 2000q4) from our investigation period. MLS_{t-1} is a dummy variable that is equal to one if the TED spread is higher than its 75th percentile at time t-1 throughout the entire sample. $Z_{i,t-1}$ is a dummy variable that is equal to one if bank i is more reliant on market liquidity (NSFR<100%) at time t-1 or 0 otherwise. size is the natural logarithm of total assets. ROA is return on asset. NPL is non-performing loans over total loans. Dummy_gap is a dummy variable equals to one if the bank is operating below its target total capital ratio ($GAP_{i,t-1} > 0$) or 0 otherwise. GDP growth is the quarterly growth rate of GDP. M&A is a dummy variable for mergers and acquisitions. It is equal to one if the asset growth rate is lower than 10% during the quarter and zero otherwise. “large” corresponds to banks with total assets higher than \$1 billion and “small” corresponds to banks with total assets lower or equal to \$1 billion. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level.

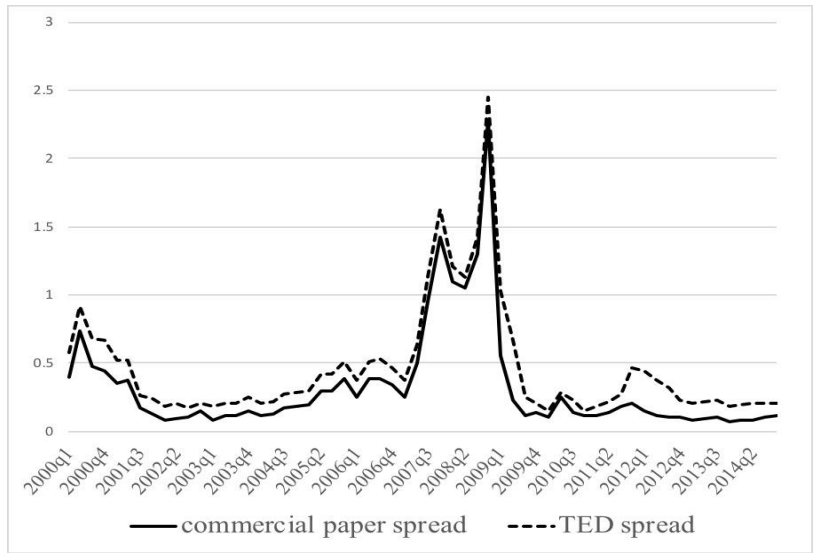
	ΔTCR		ΔRWA		$\Delta LOAN$		$\Delta ASSET$	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
$MLS_{t-1} (\varphi_1)$	-0.0500 (0.503)	0.736*** (0.0767)	0.851 (0.573)	-0.444*** (0.140)	-0.871 (0.616)	-1.049*** (0.111)	-3.596*** (0.566)	-2.159*** (0.123)
$Z_{i,t-1} (\varphi_2)$	0.0546 (0.191)	0.0737*** (0.0147)	-0.279 (0.254)	-0.140*** (0.0261)	-0.677** (0.280)	-0.259*** (0.0268)	0.0869 (0.226)	-0.0139 (0.0291)
$dummy_gap_{i,t-1} (\varphi_3)$	0.634*** (0.107)	0.465*** (0.0175)	-0.974*** (0.147)	-1.028*** (0.0356)	-0.449*** (0.168)	-0.557*** (0.0310)	0.422*** (0.152)	0.198*** (0.0321)
$Z_{i,t-1} * MLS_{t-1} (\varphi_4)$	0.151 (0.176)	0.0779*** (0.0235)	0.322 (0.238)	-0.215*** (0.0438)	0.238 (0.304)	-0.173*** (0.0396)	0.0635 (0.248)	0.174*** (0.0397)
Size $_{i,t-1}$	-0.136 (0.271)	0.904*** (0.0611)	0.748** (0.355)	-0.685*** (0.0707)	-0.298 (0.329)	-1.075*** (0.0810)	-2.288*** (0.290)	-2.334*** (0.0953)
ROA $_{i,t-1}$	0.252*** (0.0511)	0.362*** (0.0134)	-0.0380 (0.0678)	-0.173*** (0.0191)	-0.133* (0.0739)	-0.292*** (0.0198)	0.298*** (0.0641)	0.229*** (0.0156)
NPL $_{i,t-1}$	0.0672** (0.0270)	0.0905*** (0.00439)	-0.103*** (0.0320)	-0.132*** (0.00685)	-0.149*** (0.0379)	-0.179*** (0.00735)	-0.239*** (0.0461)	-0.293*** (0.00798)
GDP growth $_{t-1}$	0.257 (0.307)	0.140** (0.0546)	0.0402 (0.297)	0.457*** (0.0935)	0.0905 (0.372)	0.504*** (0.0917)	-1.177*** (0.271)	-0.815*** (0.0992)
$M\&A_{i,t-1}$	1.024*** (0.132)	1.285*** (0.0418)	2.847*** (0.236)	3.291*** (0.0735)	2.045*** (0.271)	3.672*** (0.0836)	-15.30*** (0.293)	-13.07*** (0.0885)
Banks fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
$\varphi_1 + \varphi_4$	0.101	0.814	1.173	-0.658	-0.634	-1.222	-3.532	-1.985
Wald test p value	0.795	0.000	0.0204	0.000	0.245	0.000	0.000	0.0854
r2	0.0813	0.191	0.125	0.0950	0.0790	0.133	0.625	0.532
N	14049	199275	13882	198499	13882	198506	14049	199275

TABLE 5: Impact of market liquidity shortages according to gap between actual and target capital during non-crisis period

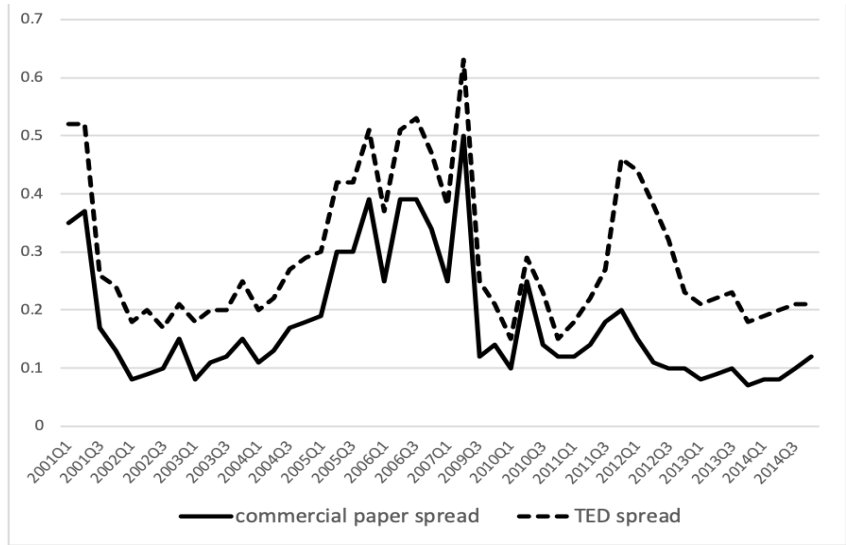
This table displays during non-crisis period, the impact of market liquidity shortages on the change in total capital ratio (ΔTCR), on the change in asset share of risk weighted assets (ΔRWA), on the change in asset share of total loans ($\Delta LOAN$) and on the change in total assets ($\Delta ASSET$) according to whether or not the bank is operating below its target total capital ratio. We exclude the crisis periods (2007q3 to 2009q2 and 2000q1 to 2000q4) from our investigation period. MLS_{t-1} is a dummy variable that is equal to one if the TED spread is higher than its 75th percentile at time t-1 throughout the entire sample. $Z_{i,t-1}$ is a dummy variable that is equal to one if bank i is more reliant on market liquidity ($NSFR < 100\%$) at time t-1 or 0 otherwise. $size$ is the natural logarithm of total assets. ROA is return on asset. NPL is non-performing loans over total loans. $Dummy_gap$ is a dummy variable equals to one if the bank is operating below its target total capital ratio ($GAP_{i,t-1} > 0$) or 0 otherwise. GDP growth is the quarterly growth rate of GDP. $M\&A$ is a dummy variable for mergers and acquisitions. It is equal to one if the asset growth rate is lower than 10% during the quarter and zero otherwise. “large” corresponds to banks with total assets higher than \$1 billion and “small” corresponds to banks with total assets lower or equal to \$1 billion. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level.

	ΔTCR		ΔRWA		$\Delta LOAN$		$\Delta ASSET$	
	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
$MLS_{t-1} (\omega_1)$	0.0588 (0.429)	0.743*** (0.0763)	1.140** (0.525)	-0.472*** (0.140)	-0.728 (0.609)	-1.122*** (0.110)	-3.752*** (0.545)	-2.043*** (0.122)
$Z_{i,t-1} (\omega_2)$	0.105 (0.153)	0.0958*** (0.0144)	-0.170 (0.212)	-0.201*** (0.0257)	-0.598** (0.255)	-0.309*** (0.0253)	0.105 (0.201)	0.0360 (0.0272)
$dummy_gap_{i,t-1} (\omega_3)$	0.626*** (0.114)	0.436*** (0.0178)	-0.975*** (0.154)	-0.955*** (0.0355)	-0.469*** (0.177)	-0.538*** (0.0321)	0.363** (0.162)	0.213*** (0.0337)
$dummy_gap_{i,t-1} * MLS_{t-1} (\omega_4)$	0.0312 (0.147)	0.110*** (0.0188)	-0.00423 (0.182)	-0.276*** (0.0393)	0.0838 (0.284)	-0.0735** (0.0354)	0.262 (0.247)	-0.0553 (0.0385)
Size $_{i,t-1}$	-0.137 (0.271)	0.903*** (0.0611)	0.746** (0.356)	-0.682*** (0.0706)	-0.300 (0.328)	-1.077*** (0.0811)	-2.288*** (0.290)	-2.330*** (0.0952)
ROA $_{i,t-1}$	0.252*** (0.0511)	0.362*** (0.0134)	-0.0384 (0.0678)	-0.173*** (0.0191)	-0.134* (0.0738)	-0.292*** (0.0199)	0.296*** (0.0639)	0.229*** (0.0157)
NPL $_{i,t-1}$	0.0668** (0.0271)	0.0904*** (0.00438)	-0.104*** (0.0321)	-0.132*** (0.00684)	-0.150*** (0.0375)	-0.178*** (0.00735)	-0.240*** (0.0461)	-0.295*** (0.00798)
GDP growth $_{t-1}$	0.257 (0.307)	0.140** (0.0546)	0.0394 (0.297)	0.457*** (0.0935)	0.0900 (0.372)	0.504*** (0.0916)	-1.177*** (0.271)	-0.816*** (0.0992)
$M\&A_{i,t-1}$	1.024*** (0.132)	1.284*** (0.0418)	2.848*** (0.236)	3.293*** (0.0734)	2.045*** (0.271)	3.672*** (0.0836)	-15.30*** (0.293)	-13.07*** (0.0885)
Banks fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes	yes	yes	yes
$\omega_1 + \omega_4$	0.0900	0.854	1.136	-0.748	-0.644	-1.195	-3.489	-2.098
Wald test p value	0.821	0.000	0.0258	0.000	0.235	0.000	0.000	0.000
r2	0.0812	0.191	0.125	0.0951	0.0789	0.133	0.625	0.532
N	14049	199275	13882	198499	13882	198506	14049	199275

Graph 1: The evolution of TED spread and commercial paper spread from 2000 to 2014 (average quarterly data).
 Source: Federal Reserve Bank of St Louis website



Graph 2: The evolution of TED spread and commercial paper spread during non-crisis period
 Source: Federal Reserve Bank of St Louis website



APPENDIX A:

This table presents the components and weights used to calculate the Net Stable Funding Ratio. ASF is available stable funding and RSF is required stable funding.

Components of ASF	weight %	Components of RSF	weight %
Total equity	100	Loans to Depository Institutions & Acceptances of Other Banks	100
Subordinated notes and debentures		Loans Non-Depository Financial Institutions and All Other Loans	
Time deposits of less than \$100,000 with remaining maturity one year or more		Total Trading Assets	
Time deposits of \$100,000 through \$250,000 with remaining maturity one year or more		Premises & Fixed Assets	
Time deposits of more than \$250,000 with remaining maturity one year or more		Total OREO	
Federal Home Loan Bank advances with remaining maturity more than a year		Investments in unconsolidated subsidiaries	
Other borrowings with remaining maturity more than a year		Direct and Indirect Investments in Real Estate Ventures	
Transaction deposits of Individuals, Partnerships, & Corporations	95	Total Intangible Assets	
Other Savings Deposits		nonperforming loans	
Non-brokered time deposits of less than \$100,000 with remaining maturity less than one year		Total Other Assets	
Non-brokered time deposits of \$100,000 through \$250,00 with remaining maturity less than one year		1-4 family mortgages	85
MMDAs	90	Loans secured by real estate excluding 1-4 family mortgages	
Non-brokered time deposits more than \$250,000 with remaining maturity less than one year		Agricultural Production Loans	
Non-retail transaction deposits	50	commercial and industrial loans	
Brokered time deposits with remaining maturity less than a year		Consumer Loans	
Federal Home Loan Bank advances with a remaining maturity of one year or less		Total Lease Financing Receivables	
Other borrowings with remaining maturity one year or less		non-U.S. Government Loans	65
Other Liabilities	0	Obligations of states and political subdivisions in the U. S	
Total Trading Liabilities		Mortgage-backed securities	50
Fed Funds Purchased		Asset-backed securities and financial products	
Repurchase Agreements		Other debt securities	
		Total Marketable Equity Securities	
		Fed Funds Sold	
		Reverse Repurchase Agreements	
		US Government agency obligations	15
		Securities issued by State & political subdivisions in the US	
		U.S. Treasury Securities	5
		Total Unused Commitments	
		Financial Standby LOC	
		Performance Standby LOC	
		commercial LOC	
		Total Cash & Balances Due Depository Institutions	0

APPENDIX B

Estimation of target capital ratios

This table displays the results of the estimation of equation (3) using fixed effect methodology and allowing computing the target capital ratios. MLS is a dummy variable that is equal to one if the TED spread is higher than its 75th percentile at time t-1 throughout the whole sample. NSFR is Net Stable Funding Ratio. size is the natural logarithm of total assets. ROA is return on assets, NPL is the ratio of non-performing loans to total loans. M&A is a dummy variable for mergers and acquisitions. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level. All independent variables are lagged one quarter.

	TCR	TIER ONE
Lag dependent variable	0.826*** (0.00380)	0.831*** (0.00369)
NSFR	0.000615** (0.000252)	0.000583** (0.000245)
size	0.106*** (0.0313)	0.0956*** (0.0306)
ROA	0.122*** (0.00951)	0.117*** (0.00922)
NPL	0.0657*** (0.00465)	0.0599*** (0.00456)
GDP growth rate	0.0163*** (0.00577)	0.0213*** (0.00566)
M&A	0.225*** (0.0241)	0.224*** (0.0237)
MLS ²³	-0.130*** (0.0105)	-0.129*** (0.0103)
constant	0.477 (0.598)	0.393 (0.584)
r2	0.825	0.831
N	267039	267036

23 The negative sign of the MLS coefficient could indicate that the target capital ratio would be negatively related to the market liquidity shortage. That would mean that during episodes of liquidity shortage, bank managers might lower the level of capital ratio they target due to constraints.

APPENDIX C: correlation matrix

	Δtcr	Δrwa	$\Delta loan$	$\Delta asset$	$\Delta tier$	MLS_ted	MLS_cp	Z_nsfr	Z_rwf	Z_LTCD	Z_liq	dummy_gap	dummy_gap_one	size	roa	npl	GDP growth	M&A	
Δtcr	1.00																		
Δrwa	-0.40	1.00																	
$\Delta loan$	-0.27	0.68	1.00																
$\Delta asset$	-0.33	-0.21	-0.25	1.00															
$\Delta tier$	0.99	-0.39	-0.27	-0.33	1.00														
MLS_ted	-0.05	0.02	0.03	0.05	-0.05	1.00													
MLS_cp	-0.05	0.03	0.04	0.06	-0.05	0.87	1.00												
Z_nsfr	0.05	-0.04	-0.05	-0.06	0.05	0.03	0.02	1.00											
Z_rwf	-0.01	-0.01	-0.01	0.06	-0.01	0.07	0.06	0.16	1.00										
Z_LTCD	-0.04	0.03	0.05	0.10	-0.04	0.15	0.14	0.15	0.35	1.00									
Z_liq	0.00	0.08	0.11	-0.01	0.00	0.10	0.10	0.16	0.28	0.40	1.00								
dummy_gap	0.10	-0.06	-0.04	-0.01	0.10	-0.03	-0.02	0.24	0.23	0.22	0.34	1.00							
dummy_gap_one	0.10	-0.06	-0.04	-0.01	0.10	-0.04	-0.03	0.25	0.24	0.22	0.34	0.93	1.00						
size	0.06	-0.04	-0.05	0.01	0.06	-0.03	-0.04	0.32	0.32	0.12	0.21	0.39	0.39	1.00					
roa	0.22	-0.05	-0.08	-0.05	0.23	-0.05	-0.01	-0.07	-0.04	-0.06	0.02	0.01	0.00	0.06	1.00				
npl	0.06	-0.07	-0.09	-0.18	0.06	-0.05	-0.10	0.35	0.07	0.02	0.00	0.11	0.12	0.12	-0.34	1.00			
GDP growth	0.00	0.07	0.08	-0.02	0.00	-0.34	-0.24	-0.08	-0.05	-0.08	-0.03	0.00	0.00	-0.04	0.12	-0.13	1.00		
M&A	0.27	0.10	0.10	-0.70	0.27	-0.04	-0.04	0.06	-0.05	-0.09	0.02	0.05	0.06	0.03	0.14	0.08	0.01	1.00	

APPENDIX D: adjustment speed of small banks during periods of market liquidity shortage

This table displays the estimations results of equation (11): $\Delta TCR_{i,t} = \lambda V_{i,t-1} GAP_{i,t-1} + \varepsilon_{i,t}$ using OLS methods. It illustrates the speed of adjustment of small banks during period of market liquidity shortages. The market liquidity shortage is measured by spikes in TED spread. Z is a dummy variable equals to one if the bank has NSFR lower than 100% or 0 if otherwise. It captures banks more reliant on market liquidity. $Dummy_gap$ is a dummy variable equals to one if the bank is operating below its target total capital ratio or 0 otherwise. It captures banks operating below their target capital ratio. ΔTCR is change in total capital ratio. NPL is non-performing loans to total loans ratio. All right-hand side variables are interacted with $GAP_{i,t-1}$. Standard errors are in parentheses. *indicate statistical significance at the 10% level. **indicate statistical significance at the 5% level. ***indicate statistical significance at the 1% level.

	ΔTCR
$Z_{i,t-1}$	0.0675*** (0.00631)
$dummy_gap_{i,t-1}$	0.126*** (0.0113)
$NPL_{i,t-1}$	-0.00678*** (0.00176)
constant	-0.387*** (0.0366)
Time fixed effect	yes
r2	0.0359
N	64023