Bank Capital and Liquidity Risk: Influence of Crisis and Regulatory Intervention

Mamiza Haq

Huddersfield Business School, University of Huddersfield,

Huddersfield, United Kingdom

m.haq2@hud.ac.uk

Nikhil Srivastava

School of Management, Bennett University

India

nikhil.srivastava@bennett.edu.in

David Tripe*

School of Economics and Finance, Massey University

Palmerston North, New Zealand

D.W.Tripe@massey.ac.nz

Zihe Wang

UQ Business School, The University of Queensland

St. Lucia, Brisbane, Australia

wziyi20@gmail.com

Abstract

This study investigates the effect of capital on asset and liability-liquidity risk measures and the impact of periods of stability and crises. Using an unbalanced panel of 18,670 commercial banks in the USA from 1993Q1-2021Q2, we find some variation across our measures of liquidity risk. For instance, on the asset side of the balance sheet, capital tends to worsen banks' liquidity position in terms of cash and near cash assets, at all times. By contrast, on the liability-side of the balance sheet, capital enhances liquidity position (demand deposit and federal funds purchased) during normal and market crisis periods. Nevertheless, we document mixed evidence in relation to unused commitments and derivatives over crises period. During Covid-19 period, we observe bank capital enhances cash, federal funds purchased and demand deposits but worsens federal funds sold. Although an increase in money market deposits and a decrease in derivatives reflects the impact of the liquidity coverage ratio, we find no appreciable evidence of such an effect for an increase (decrease) in demand deposits (cash and near cash assets). Our results are affirmed by several robustness checks.

Keywords: liquidity risk; bank capital; crises; regulatory intervention; capital support.

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* Corresponding author. E-mail address: *D.W.Tripe@massey.ac.nz* (David Tripe)

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1. Introduction

While solvency and liquidity risks within the banking sector are distinct, they are closely related. A bank could find itself insolvent yet possess sufficient liquidity, or conversely, be solvent but facing liquidity constraints. It's not uncommon for situations to arise where both these risks manifest simultaneously. Conversely, a financially sound bank holds an advantage in promptly accessing liquidity, while a highly liquid bank avoids the need to hastily sell off assets, which could erode its solvency. Typically, banks do not need to overly emphasize either liquidity or solvency, but during times of crisis these factors take on elevated significance. Such crises often lead to altered customer behaviours, requiring banks to adapt their strategies accordingly. This is the backdrop for this research.

Banks face liquidity challenges due to their role in liquidity transformation (Diamond and Dybvig, 1983). The susceptibility to liquidity risk has the potential to spread contagiously, instigating bank runs, ultimately leading to failures across the whole banking system. Over the past three decades, we have seen notable innovations and substantial shifts in banks' risk-taking behavior. For instance, following the terrorist attacks on September 11th, 2001 and the 2007/2008 financial crisis, regulatory authorities swiftly bolstered stability in financial markets by injecting liquidity into financial institutions. The Federal Reserve enacted measures like reducing short-term rates in the federal funds market, consequently prompting a surge in consumer, mortgage, and corporate debt financing. However, this credit expansion incentivized banks to relax credit quality thresholds. In the context of the "originate to distribute" model, which had been evolving over the preceding decades, issuing banks chose to downplay longer-term credit risk concerns. In this research, we evaluate the impact of bank regulation and regulatory interventions on indicators of liquidity risk. We achieve this by breaking these indicators down into distinct asset and liability liquidity risks. Through this analytical framework, we aim to ascertain the extent to which capital requirements play a role in helping

banks navigate liquidity in both stable times and periods of upheaval. We consider diverse scenarios, spanning both banking and market crises, in addition to the exceptional circumstances brought about by the Covid-19 pandemic.

Capital has always been significant for banks' operations. For example, it serves a pivotal role in absorbing losses (Repullo, 2004; Von Thadden, 2004, and Shim, 2013) and helps mitigate banks' risks by imposing controls on their risk-taking (Furlong and Keeley, 1989). This has been particularly emphasized since the initial 1988 Basel Accord. On an international scale, regulatory bodies have directed considerable attention towards banks' capital, prompting subsequent revisions of capital-related guidelines. The Global Financial Crisis (GFC) served as a pivotal event that underscored crucial concerns regarding bank capital. This led to the formulation of Basel III, a framework that, by and large, increased capital thresholds for banks and introduced worldwide benchmarks for bank liquidity.

Despite varying perspectives regarding the connection between capital and bank risk, regulatory authorities have opted to enforce more stringent capital benchmarks. But do elevated capital levels alleviate banks' liquidity risk, aligning with the intended objectives of regulators? These changes in regulatory frameworks have impacted banks' vulnerabilities to both solvency and liquidity risks. These vulnerabilities have undergone further assessment amidst the challenges posed by the pandemic and the strategies undertaken in response to it.

Our study contributes to the existing banking literature in several important ways. First, given the significance accorded to bank liquidity and the regulatory emphasis on it, we examine banks' liquidity risk in depth. To gain insights into bank liquidity risk, we dissect overall liquidity risk into distinct categories. In doing so, we employ alternative variables to serve as proxies for banks' liquidity risk, looking at it from both the asset and liability sides of their balance sheets. We further note that the impact of liquid assets and liabilities on overall liquidity risk may not be uniform for banks of differing sizes – small, medium, and large. While

prior research, built on the pioneering efforts of Berger and Bouwman (2009), has extensively explored liquidity creation (e.g.; Evans and Haq, 2022), our particular focus is on the constituents of liquidity risk, rather than overarching measures like the liquidity coverage ratio or the net stable funding ratio introduced under Basel III. Notably, while those two measures provide guidelines for gauging banks' liquidity risk, they do not inherently identify or analyze stress scenarios, nor do they reveal the way pertinent variables undergo transformations in such situations (Zhang et al., 2020).

Second, we study regulatory interventions and bank rescues effected through capital infusion. We extend prior work such as that of Berger et al. (2016), Beccalli et al. (2015), and Berger and Bouwman (2013). One perspective involves exploring the ramifications of changes during the period 2003-2004, particularly in the context of securitization. We recognize that such changes could have an impact on banks' liquidity risk. Further, our inquiry explores the repercussions of capital support provided as part of the Troubled Asset Relief Program (TARP) on banks' liquidity risk. Our study thus aspires to broaden the understanding of the interplay between regulatory interventions, capital injections, and their implications for banks' liquidity risk.

Finally, this study adds to the expanding literature (e.g., Stulz et al., 2022; Passmore and Temesvary, 2022; Chen et al., 2021) exploring the potential repercussions of bank capital —in terms of both regulatory measures and leverage ratios — on liquidity risk. Our research sheds light on the extent and magnitude of this impact, and delves into the divergent outcomes that may emerge during banking and market crises, and during periods of stability. Covering the period from 1993Q1 to 2021Q2, our study looks not only at a number of crises that have impacted banking and financial markets but also the recent health crisis around the Covid-19 pandemic. This puts us at the forefront of those exploring these dynamics within the context of

an extensive examination of the interplay between bank capital and liquidity, thereby contributing novel insights.

Using an unbalanced panel of 18,670 US commercial banks over 1993Q1-2021Q2, our findings show that, on average, bank capital tends to decrease cash and near cash assets in crisis periods. This is consistent across small and medium-sized banks. Interestingly, capital also appears to bolster liquidity, especially federal funds sold, predominantly for small banks. Furthermore, the influence of capital extends beyond crisis periods: during normal phases and even in market crises, it augments liquidity. This enhancement is manifested in several areas, including demand deposits and federal funds purchased.

In relation to the Covid-19, our results show distinct associations between bank capital and liquidity. Notably, we identify a positive association between bank capital and cash reserves, but a negative association between bank capital and federal funds sold. These patterns are particularly pronounced among small and large banks. Moreover, for liability side liquidity, our analysis underscores a positive association between bank capital and metrics such as federal funds purchased and demand deposits. This suggests that higher levels of bank capital are linked with increased liability-based liquidity indicators.

Our findings explore the association between off-balance sheet activities (namely, unused commitments and derivatives) and bank capital, with notable variations across different bank sizes. Particularly among small banks, there is a robust and positive association between off-balance sheet items and bank capital, during both market and banking crises. However, for large banks, we see an association between bank capital and off-balance sheet items, with a negative relationship observed between bank capital levels and off-balance sheet activities.

The impact of capital support varies by bank size. For small banks, an increase in bank capital appears to bolster cash reserves and demand deposit holdings. Conversely, medium-sized banks tend to decrease their demand deposit holdings under similar capital support

conditions. Our results also suggest that increased bank capital as a consequence of capital support initiatives leads to a reduction in off-balance sheet items. This underscores the intricate interplay between bank capital levels and the utilization of off-balance sheet elements.

Our analysis highlights notable consequences of regulatory intervention. Particularly among small and medium-sized banks, increased capital levels appear to lead to a reduction in cash reserves but an increase in federal funds sold. Regulatory intervention seems to prompt a decrease in both demand deposits and federal funds purchased for these banks, while we also observe a decrease in unused loan commitments and a concurrent increase in derivative positions. These findings shed light on the varied consequences of regulatory actions on liquidity indicators among banks of different size.

Finally, our analysis yields compelling evidence that shifts in money market deposits can be attributed to regulatory modifications. This effect is particularly pronounced among large banks with total assets surpassing $250 billion. We also uncover a reduction in derivatives associated with the regulatory adjustments, particularly for banks with total assets in the range $50 billion to $250 billion. We find that cash and near cash assets declined over the pre-crisis period, affirming the lack of substantial impacts from regulatory changes.

The remainder of the paper is structured as follows. Section 2 presents a literature review which forms the basis for our expected findings, against the background of events in the US banking sector. Section 3 provides details on the data and research method. Section 4 presents the empirical results, while section 5 reports robustness tests. Section 6 concludes with some policy implications.

2. Prior research and the history of relevant events

2.1 Theoretical review: bank capital and liquidity risk

Capital plays a pivotal role in equipping banks to confront potential shocks to their asset values, while also enabling them to take advantage of unplanned opportunities. It also provides

for banks to communicate their stability to both the market and credit rating agencies (Repullo, 2004; Von Thadden, 2004; Shim, 2013). Adherence to minimum capital requirements is crucial, as any breach in these can entail substantial costs for banks, such as regulatory intervention or even closure of the bank.

Better capitalized banks are better positioned to manage losses, giving them greater flexibility in selecting borrower projects (Furlong and Keeley, 1989). Such banks are also incentivized to undertake more vigilant monitoring of borrower relationships, thus reducing the likelihood of borrower default (Holmström and Tirole, 1998) while safeguarding their prerogatives of control (Jeitschko and Jeung, 2005). Likewise, shareholders of well-capitalized banks might face greater losses in the event of defaults, thereby motivating a preference for conservative asset portfolios. This interplay underscores the many advantages for banks of maintaining a robust capital position.

A strand of theoretical literature suggests that higher capital levels might not invariably lead to a reduction in bank risk. A case in point is offered by Kahane (1977), who contends that minimum capital prerequisites on banks might not, in isolation, effectively curtail the likelihood of defaults. This stems from the individual risk preference structures inherent within banks—a perspective that finds support from Koehn and Santomero (1980) and Kim and Santomero (1988). Nonetheless, the relationship between higher bank capital and risk is complex. For instance, increased bank capital can potentially stimulate greater risk-taking, attributed to mechanisms such as the avoidance of bankruptcy costs (Orgler and Taggart, 1983), managerial aversion to risk, and the dilution of ownership (Besanko and Kanatas, 1996). This interplay underscores the multifaceted nature of the relationship between bank capital and risk.

Furthermore, banks operating with insufficient capital tend to adopt a more cautious approach in selecting borrower projects. This stems from their proximity to the minimum capital requirement, which could necessitate costly adjustments or even insolvency should their

capital levels fall below the threshold (Hellmann, Murdock, and Stiglitz, 2000). However, Calem and Rob (1999) contend that under-capitalized banks might engage in heightened risk-taking. This is driven by moral hazard dynamics, where banks exploit the risk-shifting advantages offered by deposit insurance. For instance, when capital increases, under-capitalized banks might decrease their exposure to risk. Yet, if capital continues to increase beyond a certain point, they might paradoxically increase their risk-taking.

Owing to their role in liquidity transformation — accepting short-term deposits and issuing long-term loans — banks are susceptible to liquidity risks, which can trigger broader and interconnected threats (Diamond and Dybvig, 1983). One aspect of liquidity risk arises if banks ae compelled to rapidly offload illiquid assets at discounted prices to meet customer demands for liquidity (Diamond and Rajan, 2011).

Increasing the liquidity of a bank's assets can yield a counterintuitive outcome: heightened instability and an increased likelihood of failure (Wagner, 2007). This phenomenon is attributed to the fact that when a bank's assets are highly liquid, crises become less financially burdensome. This can prompt excessive liquidity risk-taking, which may ultimately outweigh the direct stability-enhancing benefits conferred by asset liquidity. Similarly, abundant liquidity on the liability side of a bank's balance sheet, typified by an influx of demand deposits, can exacerbate moral hazard issues related to risk-taking. It can trigger excessive lending and the emergence of asset-price bubbles, a dynamic elaborated upon by Acharya and Naqvi (2012). However, Acharya et al. (2011) propose a contrasting viewpoint, suggesting that banks with surplus liquidity are driven to strategically withhold liquidity from banks experiencing liquidity deficits. This benefits the surplus banks, as it compels deficit banks to sell assets hastily at discounted prices due to their liquidity shortages. This argument underscores the notion of "predatory behavior" exhibited by banks with surplus liquidity, capitalizing on the

vulnerabilities of their liquidity-deficient counterparts[1]. The potential negative implications associated with the need to conduct fire-sales of assets, the spectre of regulatory intervention, and the looming threat of insolvency collectively motivate financially sound banks to conserve liquid funds. This serves the dual purposes of reducing the risk of bankruptcy and positioning themselves to capitalize on prospective investment opportunities (Diamond and Rajan, 2009).

2.2 Empirical evidence: bank capital and liquidity risk

The empirical research examining the significance of both bank capital and liquidity has been comprehensively documented. For instance, Vasquez and Federico (2015) illuminate the link between smaller banks characterized by lower pre-crisis liquidity levels and diminished capital, and their increased vulnerability to failure in the aftermath of financial crises. Banks with less liquid asset portfolios tend to enhance their liquidity by expanding their cash reserves, increasing holdings of liquid assets, and reducing investments such as loans and loan commitments (Cornett et al., 2011).

During crisis periods, banks with healthy liquidity or stable sources of financing — such as capital and core deposits — tend to continue lending and are less hampered by the constraints imposed by the crisis itself. This aligns with the findings of Beltratti and Stulz (2012), who highlight that banks with high Tier 1 capital levels and ample deposits performed better during the financial crisis.

A crucial prerequisite for banks to experience positive credit growth when increasing bank capital is adequate asset liquidity. The interplay between bank capital and asset liquidity can exert a joint influence on the lending decisions undertaken by banks (Kim and Sohn, 2017).

[1]Cornett et al. (2011) find that when US commercial banks have more illiquid assets and off-balance-sheet loan commitments, they tend to store more liquidity, while Repullo (2005) confirms that a central bank's "lender of last resort" (LOLR) function allows banks to store lower levels of liquid assets as they know they can rely on LOLR. As a result, the probability of requiring emergency liquidity assistance increases. Acharya et al. (2011) also support this argument that liquidity support for failed banks or unconditional support for surviving banks gives banks incentives to hold less liquidity.

A higher leverage ratio can lead to better asset choices by bank managers and increased liquidity when assessing banks individually. However, this elevated leverage also renders the overall banking system more fragile. In such scenarios, the disciplining impact of a bank's capital structure on pre-emptive asset selections becomes compromised, blurring the boundaries between micro-prudential and macro-prudential regulations (Acharya et al, 2016)[2].

Government intervention and capital support can also influence a bank's liquidity risk. Empirical investigations support the notion that government intervention can induce a reduction in risk-taking behavior. This primarily stems from banks' apprehension of the government's ability to revoke their licenses and the amplified costs of government interventions, as underscored by Dahl and Spivey (1995). However, the impact of regulatory interventions, including capital constraints, can be nuanced. While they put pressure on banks, these measures might not restrain their propensity for risk-taking. This aligns with the insights of Hellmann et al. (2000), Furlong and Keeley (1989), Repullo (2004), and Von Thadden (2004).

Considering these issues, we incorporate both government intervention and capital support in our study to examine their potential effects on banks' liquidity risk. We anticipate that heightened regulatory intervention and increased capital support could lead to a reduction in bank liquidity risk.

2.3 Developments over the period of the study

In 1993, the US economy entered a phase of recovery after grappling with difficulties faced by numerous financial firms throughout the late 1980s. 1993 also saw the implementation of the initial Basel capital accord, which took effect at the beginning of the year. 1998 brought the collapse of Long-Term Capital Management (LTCM), while 2001 saw the fallout from the

[2]Financial crises are typically associated with a few highly-levered banks suffering portfolio shocks that cause capital or liquidity shortages for those banks, entangling other banks as the crisis deepens. Some early empirical studies on banking crises have argued that higher bank capital was often associated with a lower probability of failures (Estrella et al., 2000).

dot-com crash and the devastating 9/11 attacks, necessitating substantial interventions within the financial system. These interventions, in turn, contributed to a housing market bubble, the eventual bursting of which in 2006 set off the GFC, reaching its critical point in 2008. Despite the Euro crisis of the early 2010s not notably affecting the United States, the country did experience significant ramifications from the 2020 Covid-19 pandemic. This series of events underscores the volatile nature of the global financial landscape and its interconnectedness with economic and geopolitical factors.

Pre-crisis regulatory interventions, notably the implementation of the Net Capital Rule in 2004 and the exemption of special purpose vehicles (SPVs) from bank consolidation as directed by the Financial Accounting Standards Board (FASB) in 2003, are acknowledged as exerting an impact on the capital and liquidity positions of banks (explored by Beccalli et al. 2015).

An essential role of SPVs is facilitating the conversion of less liquid, unrated exposures into more liquid, rated securities. This transformation gives originating institutions enhanced liquidity through an expanded funding base and reduced funding costs (Bank for International Settlements, 2009). Smaller banks, which might lack direct market access, can pool their exposures with other small institutions, enabling them to issue debt in an economical manner while capitalizing on government guarantee programs. The exemption stemming from the 2003 FASB directive, related to the consolidation of SPVs, had a noteworthy impact. This stipulated that "assets in conduits were not considered assets for the purpose of calculating capital requirements" (as elucidated by Acharya et al., 2013), providing commercial banks with favorable capital treatment when they securitized assets.

Subsequently, following the midpoint of 2004, the Federal Reserve initiated a series of interest rate hikes amid concerns of inflation. This escalated interest costs, contributing to a

surge in mortgage defaults within the subprime market, where rates were adjustable. The resultant foreclosures reinforced a growing downward trajectory in housing prices.

Banks commonly rely on each other to secure cash for meeting their daily liquidity requirements. This is built upon the expectation that banks will reciprocate by repaying borrowed funds, leading to generally low spreads on interbank borrowings. The financial landscape during the 2008-2009 period was however marked by an unease among financial institutions, which lead to banks hesitancy in lending to each other. This contributed to a broader and more pervasive liquidity crisis that impacted multiple levels of the financial system. Following the 2007/2008 crisis, the U.S. Congress introduced legislative measures that gave rise to the Troubled Asset Relief Program (TARP). This involved the allocation of up to USD 700 billion in taxpayer funds to buy toxic assets from failing financial institutions and inject equity into them. The regulatory landscape underwent further changes with the Dodd-Frank Act of 2010, which introduced more stringent regulations, although subsequent efforts were made to moderate the impact of the Dodd-Frank Act's provisions. Basel III also followed from the crisis, elevating the required capital levels for banks and introducing liquidity standards as part of its regulatory framework.

The COVID-19 pandemic marked the first major trial for the global financial system since the reforms implemented in response to the 2008 financial crisis. In contrast to the 2008 crisis, this shock emerged from sources external to the financial system. During its more intense phases, the pandemic-induced stress created a high demand for cash and near-cash assets, effectively initiating a 'dash for cash'. This led to significant imbalances in the supply and demand for liquidity necessary to facilitate intermediation within the financial system (Financial Stability Board, 2021).

The rapid contraction of economic activity and the accompanying uncertainty as to the trajectory of the pandemic sparked a preference for holding deposits and the most liquid assets.

This shift disrupted financial markets and posed a substantial threat to the overall economy (Milstein and Wessel, 2021). Regulatory bodies stepped in to support financial markets and the economy through measures such as slashing the federal funds rate target, substantial purchases of debt securities, and extending low-interest rate loans, for up to 90 days, to 24 major financial institutions against commercial paper and municipal bonds. Furthermore, the Federal Reserve took proactive steps, such as establishing a facility to lend to banks based on collateral purchased from prime money market funds. They encouraged lending by reducing the discount window rate from 2.25% to 0.25%, and permitted both large and small banks to tap into their regulatory capital and liquidity buffers to boost lending.

The response to the pandemic offers a further avenue to investigate the relationship between capital and liquidity risk. Our empirical analysis delves into these theoretical considerations and events in the following sections.

3. Data and methodology

3.1 Sample composition and sampling procedure

Our sample consists of quarterly USA commercial bank data from *Report of Condition and Income* (also known as the 'call report'). The sample period from 1993Q1 to 2021Q2 covers a considerable number of banking and financial market crises, as outlined in the previous section. The initial period examined in our study was marked by deregulation, culminating in the enactment of the Financial Services Modernization Act of 1999, commonly referred to as the Gramm-Leach-Bliley Act. This legislation relaxed restrictions on geographic and business activities within the financial sector. Our sample period also encompasses other regulatory interventions such as the exemption of special purpose vehicles from consolidation, modifications made to the net capital rule by the Securities and Exchange Commission (SEC), and the provision of government capital support through the Troubled Asset Relief Program

(TARP). The integration of these within our analysis adds depth to our understanding of the dynamics at play during this period.

Our dataset comprises an unbalanced panel, featuring a total of 18,670 commercial banks operating within the USA. Across this panel, we have 973,546 bank-quarter observations, providing a robust foundation for our analytical exploration[3]. The data is winsorised at 1st and 99th percentile for all bank-level variables to eliminate potential outliers.

3.2 Variable measurement

3.2.1 Dependent variable-liquidity risk

Liquidity risk can arise from both the liability and asset sides of a bank's balance-sheet. Asset-side liquidity risk can arise from transactions that result in an exchange for another kind of asset, for example the exercise of loan commitments. Another type of asset-side liquidity risk arises from a bank's asset portfolio where, during sell-offs, liquidity dries up and illiquid assets have to be sold at fire-sale prices. On the liability-side of a bank's balance-sheet, liquidity risk can arise when a depositor, creditor, or other claim holder demands cash in exchange for their claim, for example the withdrawal of funds from the bank (Saunders and Cornett, 2011).

We measure banks' liquidity risk by considering both the asset and liability sides of their balance sheets. We use alternate variables to measure a bank's liquidity risk to understand the effect and magnitude of capital on liquidity, which can be different and can effectively cancel each other out, for an unchanged overall result. Instead of using a one-off general measure for bank overall liquidity risks, the alternate variable approach can provide a more comprehensive and detailed view of a bank's internal liquidity position. This is different from the approach followed by Chen et al. (2021) or Stulz et al. (2022) who use single ratios. For instance: when banks are flush with capital, they may increase their cash holdings but decrease

[3] More specifically, our sample includes 15,711 small, 2,055 medium and 904 large banks.

their interbank assets, resulting in an unchanged overall liquidity position. By using alternate variables, each component of a bank's liquidity risk can be scrutinised.

On the asset-side of the balance-sheet, alternate variables include cash and near-cash assets, Federal funds sold and reverse repurchases. Higher ratios indicate a healthier liquidity position and lower liquidity risk. For example, when banks hold a large portion of cash and near-cash assets relative to total assets, they are more likely to meet their short-term obligations without incurring liquidity problems such as a lack of cash or a need to fire-sale assets. Federal funds sold are excess bank reserves lent in the federal funds market and hence banks acquire an asset, while reverse repurchases (repos) reflect excess liquidity in a bank, occurring after covering their liabilities, investing, and lending. Both federal funds sold and reverse repos help banks manage liquidity.

On the liability-side, alternate variables used are demand deposits, money market deposits, Federal funds purchased and repurchase agreements (Repos). In contrast to the asset-side proxies, higher ratios for liability-side proxies indicate weaker liquidity positions and higher liquidity risks. For example, when banks have more demand deposits (or money market deposits) in proportion to total assets, they are more subject to sudden withdrawals or calls on their short-term liabilities. Banks with higher short-term liabilities to total asset ratios have a greater chance of being exposed to liquidity problems, thus leading to higher liquidity risk. However, the federal funds (purchased funds) and repos markets are a liquid and flexible source of funds for banks to offset deposit withdrawals. Since the federal funds generated from the purchases are borrowed funds, not deposits, they are subject to neither reserve requirements nor deposit insurance premiums.

Off-balance-sheet activities can be viewed as either assets or liabilities, which generate non-interest income (i.e. fees and commissions). We examine banks' traditional and market related off-balance sheet activities such as unused commitments and derivatives. Banks with

high off-balance-sheet exposures are often perceived to have more fragile liquidity positions. This is because they are susceptible to off-balance-sheet risks that could necessitate immediate access to cash. However, we categorize derivatives (excluding credit derivatives) as liquid, as they can be readily bought and sold, functioning similarly to tradable securities.

3.2.2 Variable of interest-alternate bank capital proxy

We employ alternative measurements for bank capital positions. To reflect a bank's capital position from a regulatory perspective, we use the total capital ratio, whereas from a book-value perspective, we employ the leverage ratio.

In its aftermath it was evident that banks which were rescued during the GFC had capital ratios greater than the minimum requirements, raising concerns about the effectiveness of the regulatory capital adequacy measurement approach in capturing banks' true capital position. The leverage ratio has now been adopted by regulators as a backstop to risk-based capital measures, aiming to constrain excess leverage in the banking system (BIS, 2010). It may be a better vehicle for measuring the relationship between capital and risk compared with the risk-adjusted capital ratio (Demirgüç-Kunt et al., 2010). In our study we therefore use leverage ratio, calculated using a bank's book-value of equity capital divided by its total assets.

We use the total capital TOT and TIER1 capital ratios as alternative measures of capital. TOT is used for supplementary analysis and TIER1 in our robustness testing.

3.2.3 Crises, regulatory interventions, and capital support

Following Berger and Bouwman (2013), financial crises are classified as banking crises or market crises based on their origin. The banking crises variable is a dummy that takes a value of one when the sample period is from a banking crisis, and zero for periods of stability. Similarly, the market crises variable takes the value one when there are market crises and zero for periods of stability. We analyse separately the market and banking crises including Long-

Term Capital Management in 1998, the bursting of the dot-com bubble in 2000, the 9/11 terrorist attack in 2001, the 2007-2009 sub-prime lending crisis and the Covid-19 pandemic.

The most prominent regulatory changes are the new net capital rule implemented in 2004Q2 by the U.S. Securities and Exchange Commission (SEC) and the exemption from the 2003 FASB directive on the consolidation of special purpose vehicles. We employ regulatory interventions as a dummy variable that takes the value one when banks are in period of regulatory intervention or change, otherwise zero.

Finally, we incorporate a capital support dummy in our analysis. Capital support under Troubled Asset Relief Program (TARP) takes a value of one for banks that received capital support until they repaid it in full. The data for historical TARP transaction reports were obtained from U.S. Department of the Treasury website. We match each capital support transaction with our call report data based on the call report variable bank identifier and time-period. A detailed variable definition is provided in Table 1.

3.3 Bank-level control variables

Numerous empirical studies have underscored the significance of moral hazard within the realm of banking (Koehn and Santomero, 1980; Hellmann et al., 2000; Acharya and Naqvi, 2012; Berger and Bouwman, 2013; Acharya et al., 2016). Both the asset-substitution and insufficiency in monitoring effort moral hazard problems stem from a common root: bank managers are often remunerated based on the volume of work executed or the profits they generate for their institutions. Thus, the pursuit of elevated profitability or increased transaction volumes can sometimes compromise transaction quality and increase associated risks, causing potential liquidity issues to arise. We therefore incorporate bank profitability (measured by return on average equity) as a control variable.

Banks with more concentrated loan portfolios are vulnerable in the event of failure or a downturn in the concentrated sector. This can result in pronounced liquidity challenges. To

account for the potential impact of loan concentration, we introduce ratios for four primary types of loans in relation to a bank's total assets. These four categories encompass real estate loans, commercial and industrial loans, loans to individuals, and credit card loans. A high loan ratio (within any of these four loan categories) indicates a higher degree of loan concentration, suggesting potentially increased liquidity risk.

Banks encountering heightened credit risk are prone to increased likelihood of default within their asset portfolios. When multiple investments or loans default, banks encounter heightened liquidity pressures, intensifying their overall risk exposure. Interestingly, higher capital can encourage bank managers and provide them with incentives to engage in riskier investments, amplifying credit risk. To disentangle the impact of capital on liquidity risk from its influence on credit risk, we need to isolate these effects. We therefore use a commonly utilized proxy for credit risk – the loan loss allowance to total loans ratio (Bouvatier and Lepetit, 2008; Klomp and de Haan, 2012). We predict that a higher level of loan loss allowance would be associated with lower credit risk.

Brokered deposits reflect the practice where deposit brokers pool modest amounts of money from their clients, consolidating these fractional deposits into a single, substantial denomination deposit. This amassed sum is then either invested or placed as a consolidated deposit by the deposit broker. This approach gives individual investors to access to higher interest rates on their deposits. For banks, brokered deposits offer an alternative avenue for immediate cash infusion. Consequently, brokered deposits can potentially fortify a bank's funding liquidity, albeit with an inherent instability (Howden, 2014). Brokered deposits often bear higher interest rates, prompting banks to employ them for investments in high-risk endeavours, aiming for superior returns (Berger and Bouwman, 2013).

3.4 Macroeconomic-level control variables

The real GDP growth rate can exert an impact on a bank's operations and associated risks. In periods of economic expansion, investment opportunities tend to rise, prompting banks to seek additional funds to support favourable investment prospects. Increased credit demand may emerge. This raises questions about a bank's liquidity, potentially resulting in challenges. Given these dynamics, we include the real GDP growth rate into our analysis.

There has been a substantial surge in banks' asset exposure to the real estate sector. Until 2008, small and medium-sized banks had over 50% of their loans linked to real estate, while the corresponding proportion for large banks was around 40% (Krainer, 2009). This heightened reliance on real estate renders fluctuations in house prices pivotal for banks' performance and solvency. Significant changes in house prices can amplify loan defaults or cause a surge in demand for loans, triggering liquidity challenges. To account for the effect of house price fluctuations, we use the S&P house price index (HPI) as a control variable.

A rise in the unemployment rate typically corresponds to reduced household incomes, which can lead to heightened deposit withdrawals and defaults on existing loans. The 2007-2008 financial crisis highlighted how the halt in liquidity can initiate a sequence of events, leading to a more widespread systemic liquidity crisis within the banking sector. We thus include unemployment rate as a control variable to allow us to account for the potential influence of changes in the unemployment rate on the relationships examined.

3.5 Descriptive statistics and correlation analysis

Table 2 presents summary statistics for our key variables. On average, banks hold 6.6% cash balance, 3.2% Federal funds sold & reverse repurchase, 12.5% demand deposits, 12.2% money market deposit, 1.2% Federal funds purchased & repos, 14.2% unused loan commitments and 1.3% derivatives. Further, banks exhibit regulatory capital ratio of 16%, 1.524%, and 0.77% over normal, bank crisis and market crisis periods, respectively.

In an un-tabulated result, we observe consistent trends within each size category[4], aligning with the findings of Berger and Bouwman (2013). Our summary statistics indicate that large banks operate with relatively lower levels of capital than their counterparts in other size categories. Further insights reveal that large banks maintain higher cash balances, but lower figures for federal funds sold and reverse repurchase agreements. On the other hand, they have more federal funds purchased and REPOs, and hold higher money market deposits. Large banks exhibit lower levels of demand deposits compared to their counterparts (small and medium banks) and show more pronounced off-balance sheet exposures, as evidenced by higher values for unused commitments and derivatives. Furthermore, our analysis confirms that both large and medium banks exhibit higher levels of risk, particularly credit risk, when compared to small banks. Despite this heightened risk profile, large banks tend to be more profitable, as indicated by their ROE, especially during normal periods and market crises. Our observations also indicate a noteworthy decline in profitability for banks across all size categories during crisis periods. This aligns with the findings of a general reduction in profitability across the banking sector during times of crisis.

Table 3 shows the pair-wise correlation matrix. To ensure that correlations do not lead to multi-collinearity, we check the variance inflation factors (VIF). All VIF values are lower than 10, with means between 2 and 3, suggesting that multi-collinearity is not a problem.

3.6 Empirical model

We follow the work of Berger and Bouwman (2013), and estimate the following panel regressions, applying both individual bank and time fixed effects.

[4] Following the work of Berger and Bouwman (2013), we classify banks as small, medium and large. Banks with total assets less than USD 1 billion are classified as small banks, banks with total assets greater than USD 1 billion but smaller than USD 3 billion as medium, and banks with total assets greater than USD 3 billion as large banks.

$$Risk_{i,t} = \beta_1(Capital_{i,t-1} \times Normal\ time_t) + \beta_2\left(Capital_{i,t-1} \times Crises_t\right) + \gamma_1 \sum Bank - level\ control_{i,t} + \delta_1 \sum Macro - level\ control_{i,t} + \tau_t + \mu_i + \varepsilon_{i,t} \quad (1)$$

where subscript *i* denotes individual banks (*i* = 1, 2, …), and *t* time period (*t* = 1993Q1, … 2021Q2). μ_i is the bank fixed-effects, τ_t is the time fixed-effects, and ε denotes the remaining disturbance terms.

Risk is banks' liquidity risk measured using six alternate liquidity measures. *Capital* represents alternate measures of capital including TOT and LEV. Crises used in the analysis include *Bank crises, Market crises* and the *Covid-19* pandemic, alternately, with *Bank, market* and *Covid-19* being dummy variables equal to one in relevant periods and zero otherwise. *Normal time* is a dummy variable that equals one in growth periods and zero otherwise.

β_1 measures the effect capital has on a bank's liquidity during periods of stability. Based on extant literature and recent regulatory reforms such as Basel III Accord, we expect $\beta_1 < 0$, that bank capital helps reduce bank liquidity risk during periods of stability. β_2 represents the crises effect, specifically whether bank capital's effect on a bank's liquidity risk is amplified or mitigated during different types of crises. We expect β_2 <0 but with greater magnitudes, indicating that the role of capital becomes more important in crisis periods.

We further develop a framework to explore the ramifications of regulatory measures on banks' capital holdings, as well as the interplay between these regulations and a bank's liquidity position. The revised net capital rule introduced by the Securities and Exchange Commission (SEC) in 2004 grants banks the latitude to employ mathematical modelling techniques in determining risk discounts for their securities. Thus, we follow Berger et al. (2016) and develop the following panel regression model:

$$Risk_{i,t} = \beta_1\left(Capital_{i,t-1} \times Regulatory\ intervention_t\right) + \beta_2\left(Capital_{i,t-1} \times Capital\ support_t\right) + \gamma_1 \sum Bank - level\ control_{i,t} + \delta_1 \sum Macro - level\ control_{i,t} + \tau_t + \mu_i + \varepsilon_{i,t} \quad (2)$$

where subscript i denotes individual banks (i = 1, 2, …), and t time period (t = 1993Q1, … 2021Q2). μ_i is the bank fixed-effects, τ_t is the time fixed-effects, and ε denotes the remaining disturbance terms.

An outcome of this regulatory change is the potential for increased bank leverage. Other regulatory initiatives have also had significant impacts. The 2003 directive from the Financial Accounting Standards Board (FASB) is a prime example. This enabled banks to receive preferential treatment for capital for asset securitization, by allowing assets held in conduits to be excluded from the calculation of capital requirements (Acharya et al. (2013). Hence, we hypothesize $\beta_1 < 0$, that regulatory interventions tend to reduce a bank's liquidity risk.

In line with previous empirical studies (e.g.; Black and Hazelwood, 2013; Berger and Roman, 2015), we analyse the impact of the Troubled Asset Relief Program (TARP) intervention. To do this, we construct a binary dummy variable that takes the value one for banks that received TARP assistance and zero for those that did not[5]. The TARP intervention, by its nature, mechanically elevated the capital ratios of recipient banks. Consequently, we anticipate that TARP-recipient banks would manifest higher capital ratios. In contrast, our hypothesis is that these same TARP-recipient banks would exhibit a reduced propensity to create liquidity. This is based on the notion that the TARP intervention acted as a signal to risk-averse depositors that the banks were in a weakened state. Hence, we hypothesize that the coefficient (β_2) should be negative, signifying that the provision of capital support through TARP is likely to diminish banks' liquidity risk.

[5] Due to the TARP being enacted during the financial crisis, the dummy variable cannot equal one in the pre-crisis period.

4. Empirical results

4.1 Does bank capital affect liquidity risk during periods of stability and market crisis?

4.1.1 Liquidity risk: asset-side

Table 4 presents the regression results for leverage (Lev) ratios[6]. Our investigation into the interplay between capital and liquidity shows an adverse association between cash and the leverage ratio. This is exemplified by the coefficients on *Lev×normal* and *Lev×mktcrisis*, which stand out as negative and statistically significant at the 1% level. An increase in leverage is linked to a reduction in cash and near cash assets, potentially elevating liquidity risk. This relationship holds true for both periods of stability and market crises (see column 1). Specifically, a one standard deviation increase in bank leverage corresponds to a 4.3% reduction in cash and near cash assets during market crisis periods, and an even more substantial 8.3% reduction during stable periods. This finding is consistent across small and medium-sized banks.

Our analysis also extends to federal funds sold, representing excess bank reserves lent in the federal funds market. The coefficients related to the interactions of leverage with normal and market crisis periods are positive and statistically significant at the 1% level. This suggests that amplified leverage tends to engender an upswing in federal funds sold during both stable and market crisis periods, with a more pronounced effect for small banks. From a quantitative standpoint, a one standard deviation increase in leverage corresponds to a noteworthy 11.8% rise in federal funds sold during market crises.

Our results underline the heterogeneous influence of bank capital on asset-side liquidity ratios, taking into account varying bank sizes and crisis conditions. A Chow test further substantiates the statistical and significant differences between crisis and stable periods. Our

[6] We tabulate the results for small, medium and large banks separately in Appendix A1 and A2.

findings align with Estrella et al. (2000), showing the consistency of our study with existing literature.

4.1.2 Liquidity risk: liability-side

We next look at liquidity risk indicators from the liability side. These metrics do not consistently influence bank capital, but increased leverage measures coincide with a reduction in money market securities such as federal funds purchased and repos, in both stable and market crisis periods. Economically, an increase of one standard deviation in bank leverage is linked to a 9.1% reduction in money market securities during periods of stability, and a 5.9% reduction during market crisis periods. This pattern holds across all banks in our dataset and aligns with Passmore and Temesvary (2022).

We find that an increase in the leverage ratio is associated with an increase in money market deposits (*see* column 4), particularly during periods of stability and market crises, with a more distinct effect observed among medium-sized banks.

Throughout stable and market crisis periods, a decrease in capital is linked to increased demand deposits. This is especially the case for small banks over stable and market crisis periods, and for medium-sized banks during stable periods. Economically, a one standard deviation increase in the leverage ratio is associated with a 8.3% and 3.8% decrease in demand deposits in stable and market crisis periods, respectively.

Our analysis corroborates the statistically significant distinction between the variables across these two distinct periods, as confirmed by a Chow test. A decrease in deposits could lead to heightened capital requirements, given that banks' borrowing capacity diminishes. Consequently, banks tend to contract their balance sheets, opting for a more risk-averse portfolio, in line with Covas and Driscoll (2011).

4.1.3 Off-balance sheet exposures- derivatives and loan commitments

We also look at the significance of bank capital for off-balance sheet items, including unused loan commitments and derivatives, within stable and market crisis periods (*see* columns 6 and 7). Our results show that the coefficients for the interaction terms of *capital* ×*normal* and *capital* × *market crisis* are positively significant at the 1% level. This suggests that increased bank capital amplifies banks' exposure to off-balance sheet items, particularly among small banks. Nevertheless, there is a difference for our large banks. where during periods of stability, an upsurge in the leverage ratio exhibits a tendency to reduce banks' holdings of derivatives. These dynamics could be attributed to the underlying disciplinary role that bank capital plays in these situations.

4.2 Does bank capital affect liquidity risk during banking crises?

4.2.1 Liquidity risk: asset-side

Table 5 shows a statistically significant negative correlation between cash and bank capital measures. Increased bank capital tends to result in a decrease in cash and near cash assets across both stable and bank crisis periods (*see* column 1). This trend is particularly pronounced among small and medium-sized bank.

Significant effects are found for the influence of leverage on federal funds sold. An increase in leverage corresponds to increased federal funds sold (*see* column 2), particularly among small banks. For instance, a one standard deviation increase in the leverage ratio is associated with a substantial 22% surge in federal funds sold during banking crises.

4.2.2 Liquidity risk: Liability-side

For liability-side liquidity measures, we find that heightened capital ratios correspond to a reduction in short-term funding from federal funds purchased and Repos. This pattern is consistent across small and medium banks at all times, and among large banks during stable periods. This relationship bears economic significance, with a one standard deviation increase in the leverage ratio leading to a 13.7% decrease in federal funds purchased and REPOs during

normal periods, and a 5.9% decrease during banking crisis periods.[7] This is also evident for money market deposits, where an increase in these deposits is related to a decrease in the leverage ratio during banking crisis periods exclusively for small banks and at all times for medium-sized banks.

For demand deposits, the coefficients on *capital×normal* and *capital×bnkcrisis* are negative and statistically significant at the 1% level. This implies that during both stable and bank crisis periods, increased capital leads to a decline in demand deposits. However, this relationship varies depending on bank size and the capital measure employed. The trend is consistent for small banks across both stable and normal periods, and for medium-sized banks in stable periods. This suggests that increased capital might constrain banks' borrowing capacity, prompting them to downsize their balance sheets.

4.2.3 Off-balance sheet exposures- derivatives and loan commitments

We also look at the influence of bank capital on off-balance sheet items like unused loan commitments and derivatives during banking crises. Our examination highlights that increased bank capital typically corresponds to an increase in off-balance sheet exposures for banks, especially among small banks during both stable and bank crisis periods. Among large banks, however, we observe a negative correlation between derivatives and the leverage ratio during stable periods.

4.3 Does Covid-19 pandemic affect banks' liquidity risk?

4.3.1 Liquidity risk: asset-side

Table 6 shows the results for the impact of the Covid-19 pandemic on liquidity risk measures. For cash and near cash assets, we find that during the Covid-19 period, an augmentation in bank capital generally corresponds to an increase in cash and near cash assets,

[7] Similarly, a one standard deviation increase in regulatory capital ratio decreases federal funds purchased and REPOs by 9.7% (9.9%) during normal (banking crisis) periods.

leading to a reduction in liquidity risk. This holds true across the different measures of bank capital we examined and is especially evident for small banks. When considering federal funds sold, our results suggest that an increase in capital tends to diminish the reliance on federal funds sold, thereby raising liquidity risk. This pattern, which contrasts with the findings from our analysis of crises periods reported in sections 4.1-4.2, is particularly pronounced among small banks.

4.3.2 Liquidity risk: liability-side

We also examine how the Covid-19 pandemic has influenced the relationship between bank capital and liability side of the liquidity risk. We find that during the Covid-19 period, there is a positive association between bank capital and federal funds purchased. These results markedly differ from the findings detailed in sections 4.1-4.2.

4.3.3 Off-balance sheet exposures- derivatives and loan commitments

Next, we explore the impact of bank capital on off-balance sheet items such as unused loan commitments and derivatives, focusing on the Covid-19 period. Our results reveal that the coefficients on *LEV* × *Covid-19* are negative for derivatives, particularly for small banks.

Further, we note that the coefficient on the interaction term is negative (positive) for unused commitments (derivatives) and significantly significant at the 1% level for small banks. Furthermore, the coefficient on the leverage ratio and Covid-19 interaction is negative and statistically significant for both unused commitments and derivatives, particularly among large banks.

4.4 Do capital support and regulatory intervention affect banks' liquidity risk?

4.4.1 Liquidity risk: asset-side

Table 7 shows the results for the impact of capital support, regulatory interventions, and liquidity risk. Our results reveal several important relationships. When TARP or capital support is present, an increase in bank capital tends to elevate cash and near cash assets, leading

to a reduction in liquidity risk. This pattern is particularly noticeable among small banks, as reflected in column 1.

For regulatory intervention (INTV), an increase in bank capital tends to reduce holdings of cash and near cash assets, thereby contributing to decreased liquidity risk. This effect is observed among both small and medium-sized banks.

For federal funds sold, the coefficient on the interaction term between leverage ratio and TARP is negative and statistically significant at the 1% level. This suggests that, in the presence of TARP, an increase in leverage ratio is linked to a decrease in federal funds sold, indicating increased liquidity risk. This pattern is particularly pronounced among small banks. Economically, a one standard deviation increase in leverage ratio corresponds to a 3.2% decrease in federal funds sold. Similar results are observed for the total capital ratio. These findings underscore the intricate relationship between capital support, regulatory interventions, bank capital, and liquidity risk, shedding light on how different factors interact to influence the liquidity position of banks during periods of stress.

Certainly, in the case of medium-sized banks, our findings suggest that the presence of TARP leads to an increase in federal funds sold, potentially decreasing liquidity risk. This demonstrates how capital support measures like TARP can impact the liquidity dynamics of banks, potentially offering more room for manoeuvre in managing liquidity risk during challenging periods. Yet, our analysis indicates that regulatory intervention (INT) reduced liquidity risk for banks. This effect is driven by an increase in federal funds sold, which is influenced by an increase in bank capital. Notably, this relationship is particularly evident among small banks. Thus, different regulatory interventions can shape the liquidity profile of banks under varying conditions.

4.4.2 Liquidity risk: liability-side

Next we analyse how the presence of interventions like TARP and regulatory measures can interact with bank capital to shape the use of short-term funding sources and influence liability-side liquidity risk, with variations based on bank size and regulatory environment (*see* columns 3-5). We find that when TARP is present, there is a positive relationship between federal funds purchased and regulatory capital, particularly among large banks. This suggests that higher bank capital, in conjunction with TARP intervention, leads to increased utilization of short-term funding sources like federal funds purchased. This dynamic might impact the liquidity risk of larger banks in a specific manner. Conversely, under regulatory intervention, the coefficient on *LEV×INTV* is negative and statistically significant, signifying that the association between bank capital and federal funds purchased diminishes in the presence of regulatory intervention. This implies that regulatory intervention could prompt banks, especially smaller ones, to reduce their reliance on short-term funding sources, which may contribute to a decrease in liquidity risk.

Under the influence of TARP, our findings reveal a positive association between bank capital and demand deposits for small-sized banks, while for medium-sized banks, this association is negative (*see* columns 5). This suggests that in the presence of TARP, higher capital ratios tend to stimulate the accumulation of stable deposits for smaller banks, potentially reflecting increased depositor confidence due to improved capital positions. However, for medium-sized banks, higher capital ratios seem to be associated with a preference for using other funding sources.

Conversely, when regulatory intervention is considered, small and medium-sized banks exhibit a negative association between demand deposits and bank capital. This implies that in the presence of regulatory measures, such as intervention aimed at influencing bank behavior, an increase in bank capital is linked to a decrease in the reliance on demand deposits as a

funding source. This shift away from demand deposits could contribute to reducing liquidity risk for these banks during such interventions.

4.4.3 Off-balance sheet exposures- derivatives and loan commitments

When considering the impact of TARP, we see that an increase in bank capital is associated with a decrease in off-balance sheet items such as unused commitments and derivatives. This finding holds particularly true for small banks, indicating that higher capital levels may lead to a more cautious approach in terms of off-balance sheet exposure, possibly as a risk mitigation strategy in response to the intervention.

The influence of regulatory intervention is also evident in our analysis. For small banks, the coefficient on $TOT \times INTV$ is negative for unused commitments and positive for derivatives, implying that regulatory intervention leads to reduced unused commitments but increased derivatives exposure. This result aligns with the notion that regulatory intervention might prompt banks to adjust their off-balance sheet activities, potentially to align with the intended regulatory goals.

4.5 Regulatory reform and liquidity risk measures: DiD analysis

To assess the impact of the liquidity coverage ratio (LCR) on various bank liquidity elements, we undertake a difference-in-difference analysis spanning a window of [-2,+3] years around the treatment year (t=1) in 2013. A logical deduction can be made that the regulatory modifications predominantly influenced the largest banks, as they were compelled to swiftly adapt to the novel regulatory measures in order to meet stress test requirements and facilitate dividend distributions (Stulz et al., 2022).

We take two groups of treated banks, sorted by size as of *t-1* (2011): *Large >$250B*, banks with assets in excess of $250B and *Large $50-$250B*, banks with assets between $50B and $250B. The control group includes banks with assets *below $50B*. *Post* is an indicator

variable equal to one starting in 2013. *Pre* is an indicator equal to one for 2011 and zero otherwise. Our results are reported in Table 8 for both leverage and total capital ratios.

Our findings show that the observed increase in money market deposits is a direct result of regulatory adjustments. Notably, this trend is most pronounced among large banks with total assets exceeding $250 billion. Furthermore, our analysis highlights a decrease in derivatives, which can be attributed to regulatory modifications, particularly among banks falling within the total assets range of $50 billion to $250 billion. Significantly, our investigation confirms a decline in cash and near cash assets during the pre-crisis period, underscoring the lack of substantial evidence indicating impacts arising from regulatory changes. Lastly, our study reveals a rise in demand deposits among large banks in the pre-crisis phase, with no evident influence stemming from the regulatory adjustments.

4.6 Total capital as a capital measure

In most cases, the results generated for regulatory capital ratios are the same as for the leverage ratio, but in this section we highlight a few cases where different results are observed. Key results are reported in Table 9.

Specifically, heightened bank capital is reflected in diminished cash and near cash assets during market crisis periods, a phenomenon more pronounced for small banks. Economically, a one standard deviation increase in regulatory capital corresponds to a substantial 14% reduction in cash and near cash assets during market crises. Interestingly, during stable periods, an increase in regulatory capital appears to result in an increase of cash and near cash assets for medium and large-sized banks. This underscores the intricate relationship between regulatory capital levels and liquidity positions under varying market conditions.

Parallel trends are observable for fed funds sold for bank regulatory capital. Nevertheless, a nuanced observation comes to light for medium-sized banks, where regulatory

capital seems to lead to a decrease in federal funds sold during stable periods. A one standard deviation increase in regulatory capital is linked to a substantial 18.3% and 10.9% increase in federal funds sold during stable and market crisis periods, respectively.

Economically, a one standard deviation increase in regulatory capital ratio is associated with a 6.6% and 3.2% decrease in demand deposits in stable and market crisis periods.

The adoption of regulatory capital ratios also yields comparable outcomes, albeit with some variations based on bank size. Specifically, for small banks, the coefficients display negative values in both stable and bank crisis periods, signifying a decrease in cash assets with an increase in regulatory capital. Conversely, for medium-sized banks, the coefficients exhibit positive values in stable periods but negative values in bank crisis periods. Moreover, large banks demonstrate a positive correlation between regulatory capital and cash and near cash assets, particularly in stable periods.

Conversely, we observe a negative association between regulatory capital and federal funds sold. This suggests that the imposition of regulatory bank capital requirements curtails the extent of federal funds sold, predominantly during stable periods, especially among medium-sized banks.

An interesting exception arises where a rise in regulatory capital is linked to an increase in demand deposits during banking crisis periods, primarily among large banks.

For the banking system as a whole, an increase in regulatory capital tends to expand unused loan commitments, although among large banks we observe a negative association between unused commitments and regulatory capital measures during stable periods.

For the Covid period analysis, when regulatory measures are considered for unused commitments, this negative relationship is observed for both small and large banks. For derivatives, the coefficient on *TOT*× *Covid-19* is negative and significant at the 1% level. A

one standard deviation increase in the leverage ratio is linked to a 7.3% decrease in derivatives over the pandemic period.

For regulatory intervention, we find a negative relationship between regulatory capital (TOT) ratios and federal funds purchased for both small and medium-sized banks. This suggests that the influence of bank capital on federal funds purchased changes under the influence of regulatory intervention, potentially leading to a reduction in liquidity risk.

5. Robustness checks[8]

5.1 Alternate size cut-off

Following Berger and Bouwman (2013), we re-run the analysis using an alternative US$5 billion cut-off for medium banks. Under this alternative, around 30% of large bank observations are reclassified as medium banks. In relation to crises and stable period, our findings are largely consistent with those reported in section 4. For regulatory interventions and capital support, our results remain qualitatively the same.

5.2 Alternative bank capital proxy

Tier one (TIER1) ratio is an important capital adequacy measurement mentioned in the Basel Accords I, II and III. TIER1 ratio includes a bank's ordinary shares, retained earnings and perpetual, non-cumulative preference shares divided by its risk-weighted assets. It is regarded as a bank's primary funding source and is usually considered as high-quality capital, supporting banks absorbing unexpected losses or earnings shocks. Recognising the importance of holding high-quality capital in absorbing shocks, after the GFC, the BCBS increased the minimum TIER1 requirement from 4% of total risk-weighted assets (RWA) in Basel II to 6% in Basel III. Hence, we consider Tier 1 capital ratio as an alternate proxy of bank capital. Our overall results do not change those reported in section 4.

[8] For the sake of brevity, we do not report the results, but these are available upon request.

5.3 Low and high capitalised banks

It is often argued that low-capitalised banks and high-capitalised banks may behave differently in asset monitoring (Besanko and Kanatas, 1996; Holmström and Tirole, 1998) and portfolio choice (Koehn and Santomero, 1980; Hellmann et al., 2000; and Jeitschko and Jeung, 2005), resulting in differences in liquidity risk. Hence, we re-run our analysis separately for low- and high-capitalised banks, dividing banks based on the median value of their total capital ratios. Our results confirm that an increase in capital/leverage ratios is associated with more federal funds and less cash holdings, indicating an offset on banks' asset-side liquidity positions, consistent with our findings reported in section 4. One exception is that we observe a negative association between federal funds and leverage ratio for low-capitalised banks.

For low capitalised banks, however, an increase in risk-based capital is associated with an increase in money market deposits across both stable and crises periods, largely consistent with our findings reported in section 4. Nevertheless, for high-capitalised banks an increase in capital tends to decrease federal funds purchased and demand deposits, which in turn helps reduce liability-side liquidity risk. However, high-capitalized banks are also found to decrease money market deposits as capital increases.

Consistent with our main findings, we show that both low- and high- capitalised banks tends to increase unused loan commitments and derivatives over both stable and crises periods. However, we find some variation when we apply leverage ratio as a measure of capital. For instance, the coefficient on *LEVR*×*mktcrisis* is negative and statistically significant for low-capitalized banks. The effects of regulatory interventions and capital support on banks' asset-side liquidity risk are observed for both high and low-capitalized banks. However, we find that regulatory interventions tend to exert negative impact on federal funds, specifically for low – capitalised banks. For liability-side liquidity risk and off-balance-sheet exposures, the results remain unchanged for high-capitalized banks. Conversely, for low-capitalized banks, the

results are qualitatively the same with the exception that an increase in risk-based capital tends to decrease money market deposits.

5.4 Low and high profitability banks

Next, we divide our sample banks based on their median value of ROE and conduct our analysis for low- and high-profitability banks. Our results under asset-side liquidity risk measures are largely consistent with those reported in section 4, with some variations. For example, for high-profitability banks, an increase in total capital tends to increase cash holdings and reduce federal funds during stable period, indicating an offset on asset-side liquidity. For liability-side and off-balance-sheet liquidity risk, the effect of capital remains unaffected for low-profitability banks. For high-profitability banks, our results remain unchanged except for demand deposits under risk-based capital and in banking crisis periods. High-profitability banks have more demand deposits for increased risk-based capital during banking crises. The increase in demand deposits may potentially cause weaker liquidity positions for high-profitability banks. Further, regulatory interventions and capital support, in general, have a positive impact on banks' liability-side and off-balance-sheet liquidity risk regardless of high or low profitable banks.

6 Conclusion

This study examines the influence of bank capital on mitigating banks' liquidity risk in periods characterized by stability, banking crises, and market crises. The conflicting perspectives found in existing literature, the importance of both capital and liquidity within the Basel III Accord, the impact of capital on bank liquidity risk, and how this varies across distinct crisis scenarios and stable periods, provide a basis for an empirical investigation. We assess the effectiveness of government interventions and capital support in achieving their intended goals of reducing banks' liquidity risk. Utilizing an unbalanced panel comprising 18,670 USA commercial banks spanning from 1993Q1 to 2021Q2, our analysis unveils noteworthy insights.

We find that, on the asset side of the balance sheet, capital consistently appears to amplify the liquidity risk concerning cash and near cash assets, even during crises, for both small and medium-sized banks. When it comes to federal funds sold, capital seems to bolster the liquidity position, especially for small banks. For the liability side of the balance sheet, our results show that capital serves to enhance the liquidity position—reflected in both demand deposits and federal funds purchased—across normal and market crisis periods.

Our findings hold significant implications for banking regulators and supervisory entities, especially when formulating banking policies and enacting regulatory modifications. Capital has consistently been recognized as a pivotal element for ensuring bank stability and has been endorsed by regulators as a safeguard against potential risks and losses. Following the aftermath of the GFC, the Basel Committee on Banking Supervision (BCBS) introduced the Basel III Accord, ushering in a notable elevation in minimum capital requisites.

From the vantage point of liquidity risk, our discoveries offer a degree of validation for this rigorous capital regulation, showcasing a positive correlation between capital and the liquidity positions of banks. Nevertheless, our results also support the substitution of uniform capital requisites with tailored standards for banks of varying sizes. The rationale for instituting size-specific capital requisites lies in the non-uniform impact of capital on liquidity risk for large and medium-sized banks, which paradoxically may elevate liquidity risk.

Moreover, our analysis furnishes some evidence that, particularly during periods of crisis, bolstering a bank's capital position can be an effective strategy for regulators to manage liquidity risk. In contrast to common assumptions and regulatory expectations, we find instances where regulatory interventions and capital infusions may not consistently mitigate banks' liquidity risk. In certain cases, these measures might even engender adverse effects on a bank's liquidity risk. Consequently, regulatory bodies should reassess the provision of capital support and the appropriateness of regulatory adjustments.

Lastly, regulators and supervisory authorities should exercise heightened vigilance over any atypical fluctuations in banks' capital positions and ensure adherence to minimum capital requirements. A decline in capital positions, particularly in terms of risk-based capital, can lead to heightened liquidity risk. Hence, abrupt declines in capital should be scrutinized meticulously, as these could potentially foreshadow acute liquidity challenges.

Furthermore, we offer insights into potential avenues for future research. One promising direction involves exploring the relationship between market liquidity and various sources of bank funding, particularly within distinct crisis periods. Investigating how market liquidity fluctuations impact banks' ability to secure funding from different sources could yield valuable insights into the interconnectedness of liquidity and capital dynamics.

Additionally, delving into the intricate interplay between shifts in diverse asset classes and their influence on the relationship between capital and liquidity risk holds promise for further exploration. Understanding how changes in asset allocations can potentially mediate or exacerbate the impact of capital on liquidity risk would enhance our comprehension of the complex mechanisms at play. By pursuing these future research directions, scholars and practitioners can deepen their understanding of the intricate interactions between capital, liquidity, and market conditions, thereby contributing to the refinement of regulatory frameworks and risk management strategies in the financial sector.

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Table 1
Variable definition

This table defines liquidity risk and bank capital measures as well as determinant of bank risk used in analysis. The variable column presents the dependent variables, variable of interest, bank and country-level variables used in the models. The dependent variables include asset-liability side liquidity risk measures. Variable of interest includes alternate measures of bank capital. Bank-level variables include size, profitability, credit risk, brokered deposits, and different types of loans. We incorporate country-level variables such as real GDP growth, inflation and unemployment rates.

Variable	Definition
Dependent variables- asset and liability side liquidity risk – Alternate proxies	
Asset- Cash and near cash assets	Cash and near cash assets scaled by total assets
Asset- Federal funds sold and reverse repurchase	Total federal funds sold and securities purchased under agreements to resell in domestic offices scaled by total assets
Liability- Demand deposits	Total demand deposits included in transaction accounts held in domestic offices. This has been scaled by total assets.
Liability: Federal funds purchased and repurchase agreement	Total federal funds purchased and securities sold under agreements to repurchase in domestic offices scaled by total assets.
Liability- Money market deposit	Total money market deposit accounts held in domestic offices scaled by total assets.
Market related Off-balance sheet items	Derivatives scaled by risk-weighted assets
Traditional off-balance sheet items	Unused commitments scaled by risk-weighted assets
Variables of interest- Alternate proxies	
Bank capital – Tier 1 ratio	TIER1 ratio includes a bank's ordinary shares, retained earnings and perpetual, non-cumulative preference shares divided by its risk-weighted assets.
Bank capital- Total regulatory capital	TOT capital ratio is calculated using a bank's TIER1 plus tier two (TIER2) capital, divided by its risk-weighted assets. TIER2 consists of revaluation reserves, hybrid capital instruments, subordinated debt and general provisions.
Bank capital - Leverage ratio	Book-value of equity capital divided by its total assets
Bank-level control variable	
Size	Natural logarithm of total assets. Further, banks with a total asset less than US$1 billion are classified as small banks. Medium banks are banks with total assets greater than US$1 billion but less than US$3 billion, and large banks are banks with total assets greater than US$3 billion.
Profitability	Return on shareholder equity
Credit risk	Loan loss allowance to total loans
Brokered deposits	Total brokered deposits divided by a bank's total assets
Real estate loans	Loans secured primarily by real estate, whether originated by the bank or purchased. This variable has been scaled by total assets.
Commercial and industrial loans	Commercial and industrial loans. Excludes all loans secured by real estate, loans to individuals, loans to depository institutions and foreign governments, loans to states and political subdivisions and lease financing receivables. This variable has been scaled by total assets.
Loans to individuals	Loans to individuals for household, family, and other personal expenditures including outstanding credit card balances and other secured and unsecured consumer loans. This variable has been scaled by total assets.
Credit card loans	Consumer loans extended through credit card plans. This variable has been scaled by total assets.
Country-level control variables	
Gross domestic product (GDP)	Real GDP growth rate
House price index (HPI)	S&P house price index
Unemployment (UNEM)	Unemployment rate
Indicator variables- crises, regulatory intervention, and capital support	
Normal	Refers to the periods of growth/stability. Takes the value of one when there are no banking crises nor market crises.
Market crises (mktcrisis)	Takes the value of one during market crises. Market crisis includes, long-term capital management 1998Q3-1998Q4, the bursting of the dot-com bubble and 9/11 terrorist attack 2000Q2-2002Q3.
Banking crises (bkcrisis)	Takes the value of one during sub-prime lending crisis 2007Q3-2009Q4
Regulatory intervention (REGINV)	Takes the value of one when during regulatory interventions. The main regulatory interventions considered include 2004Q1-2004Q3 the exemption of special purpose vehicle on consolidation and the 2004Q3-2005Q3 changes of the net capital rule by the SEC.
Capital support (CAPSUP)	Takes the value of one when a bank receive capital supports and have not repaid in full. TARP program is considered as the main source of government capital support for banks.

Table 2: Descriptive statistics

This table represent the summary statistics for all variables. "Capital" represents alternate proxies of bank capital that is leverage and regulatory total capital ratios. We report the summary statistics for capital by splitting the sample into sub periods including normal, banking and market crises periods, Capital support-TARP and regulatory intervention including exception of special purpose vehicle. Table 1 provides a description of each variable.

	Number of observations	**Variable of interest -Leverage ratio**				**Variable of interest –Total capital ratio**			
		Mean	St.dev.	Min	Max	Mean	St.dev.	Min	Mean
Cash balance	973,546	0.066	0.062	0.007	0.369	0.065	0.061	0.007	0.369
Federal funds sold & reverse repurchase	973,546	0.032	0.050	0	0.286	0.032	0.050	0	0.286
Federal funds purchased & Repos	973,546	0.012	0.029	0	0.167	0.012	0.029	0	0.167
Money market deposits	918,587	0.122	0.105	0	0.528	0.122	0.105	0	0.528
Demand deposits	918,587	0.125	0.078	0	0.403	0.124	0.077	0	0.403
Unused commitments	962,485	0.142	0.115	0	0.758	0.142	0.115	0	0.758
Derivatives	882,344	0.013	0.062	0	0.483	0.013	0.062	0	0.483
Capital-normal	973546 /918,587/ 962485/882,344	9.526	5.478	0	41.154	16.466	11.686	0	90.373
Capital-bank crisis	973546 /918,587/ 962485/882,344	0.972	3.537	0	41.154	1.524	5.922	0	90.373
Capital- market crisis	973546 /918,587/ 962485/882,344	0.446	2.368	0	41.154	0.770	4.343	0	90.373
Capital-TARP	973546 /918,587/ 962485/882,345	0.023	0.513	0	41.154	0.035	0.764	0	81.746
Capital- INV	973546 /918,587/ 962485/882,346	0.710	2.978	0	41.154	1.183	5.295	0	90.373
Size	973546 /918,587/ 962485/882,344	11.773	1.370	9.05	16.411	11.767	1.372	9.05	16.411
Profitability	973546 /918,587/ 962485/882,344	9.436	9.001	-31.38	33.556	9.438	9.026	-31.38	33.556
Brokered deposits	973546 /918,587/ 962485/882,344	0.016	0.044	0	0.273	0.016	0.044	0.000	0.273
Loan loss allowance	973546 /918,587/ 962485/882,344	0.015	0.009	0.002	0.055	0.015	0.009	0.002	0.055
Real estate loans	973546 /918,587/ 962485/882,344	0.422	0.191	0	0.853	0.422	0.191	0	0.853
Commercial and industrial loans	973546 /918,587/ 962485/882,344	0.085	0.070	0	0.351	0.085	0.070	0	0.351
Loans to individual	973546 /918,587/ 962485/882,344	0.057	0.062	0	0.358	0.058	0.062	0	0.358
Credit card loans	973546 /918,587/ 962485/882,344	0.002	0.007	0	0.056	0.002	0.007	0	0.056
Real GDP growth rate	973546 /918,587/ 962485/882,344	0.012	0.034	-0.31	0.338	0.012	0.028	-0.31	0.338
House price index	973546 /918,587/ 962485/882,344	0.010	0.015	-0.04	0.055	0.010	0.015	-0.04	0.055
Unemployment rate	973546 /918,587/ 962485/882,344	0.004	0.095	-0.13	0.332	0.003	0.096	-0.13	0.332

Table 3: Pair-wise correlation analysis

This table reports the pairwise correlation analysis between the key variables used in our analysis. *****represents statistical significance at the 5% significance level. Variable definitions are provided in Table 1.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
(1) Cash	1.000																										
(2) Fed. sold	-0.042*	1.000																									
(3) Fed. purchased	-0.102*	-0.066*	1.000																								
(4) Money market deposit	0.015*	-0.037*	0.056*	1.000																							
(5) Demand deposit	0.285*	0.143*	-0.069*	0.004*	1.000																						
(6) Unused commitments	-0.028*	-0.009*	0.225*	0.264*	0.020*	1.000																					
(7) Derivatives	0.005*	-0.040*	0.196*	0.150*	-0.056*	0.253*	1.000																				
(8) LEV×Normal	0.127*	0.097*	-0.089*	-0.050*	-0.025*	-0.013*	-0.008*	1.000																			
(9) LEV × BNK crisis	-0.022*	0.037*	0.001	-0.008*	-0.099*	0.015*	-0.014*	-0.451*	1.000																		
(10) LEV × MKT crisis	-0.022*	0.077*	-0.006*	-0.035*	-0.024*	0.001	-0.016*	-0.308*	-0.051*	1.000																	
(11) TOT×Normal	0.187*	0.148*	-0.101*	-0.109*	-0.017*	-0.124*	-0.041*	0.870*	-0.365*	-0.249*	1.000																
(12) TOT× BNK crisis	0.005*	0.051*	-0.009*	-0.022*	-0.086*	-0.005*	-0.017*	-0.415*	0.950*	-0.047*	-0.335*	1.000															
(13) TOT × MKT crisis	-0.010*	0.085*	-0.011*	-0.037*	-0.020*	-0.012*	-0.017*	-0.286*	-0.047*	0.960*	-0.231*	-0.043*	1.000														
(14) LEV×TARP	0.025*	-0.017*	-0.009*	0.039*	0.013*	0.004*	0.002	0.000	0.008*	-0.008*	-0.009*	0.005*	-0.008*	1.000													
(15) TOT×TARP	0.031*	-0.017*	-0.009*	0.038*	0.015*	0.003*	0.004*	0.000	0.006*	-0.008*	-0.007*	0.004*	-0.008*	0.979*	1.000												
(16) LEV×INTV	-0.046*	0.037*	0.005*	-0.016*	-0.048*	0.042*	-0.019*	0.170*	-0.064*	-0.044*	0.132*	-0.059*	-0.041*	-0.011*	-0.011*	1.000											
(17) TOT×INTV	-0.026*	0.049*	-0.003*	-0.026*	-0.046*	0.018*	-0.020*	0.175*	-0.059*	-0.041*	0.177*	-0.055*	-0.038*	-0.010*	-0.010*	0.951*	1.000										
(18) SZE	-0.117*	-0.243*	0.299*	0.373*	-0.140*	0.386*	0.389*	-0.130*	0.010*	-0.056*	-0.217*	-0.011*	-0.061*	0.020*	0.019*	-0.025*	-0.040*	1.000									
(19) ROAE	-0.139*	-0.083*	0.097*	-0.007*	0.084*	0.089*	0.032*	-0.078*	-0.153*	0.003*	-0.092*	-0.139*	-0.003*	-0.036*	-0.035*	-0.005*	-0.016*	0.091*	1.000								
(20) Brokered deposit	-0.048*	-0.070*	0.032*	0.081*	-0.134*	0.144*	0.163*	-0.066*	0.096*	-0.031*	-0.124*	0.064*	-0.034*	0.039*	0.036*	0.007*	-0.008*	0.211*	-0.078*	1.000							
(21) Real estate loan	-0.126*	-0.267*	-0.066*	0.137*	-0.155*	-0.000	0.000	-0.178*	0.051*	-0.050*	-0.291*	0.015*	-0.058*	0.032*	0.028*	-0.004*	-0.031*	0.273*	-0.096*	0.132*	1.000						
(22) C & I loan	-0.053*	0.035*	0.103*	0.191*	0.176*	0.237*	0.086*	-0.112*	0.007*	-0.005*	-0.248*	-0.024*	-0.025*	0.028*	0.025*	-0.003*	-0.030*	0.105*	0.058*	0.142*	-0.159*	1.000					
(23) Loan loss allowance	0.093*	0.111*	0.013*	-0.014*	0.052*	0.030*	0.008*	0.072*	-0.016*	-0.007*	0.088*	-0.017*	-0.007*	0.027*	0.029*	-0.019*	-0.015*	-0.055*	-0.139*	0.047*	-0.280*	0.047*	1.000				
(24) Individual loan	-0.090*	0.053*	0.048*	-0.159*	0.012*	0.012*	0.018*	-0.048*	-0.070*	0.035*	-0.079*	-0.071*	0.022*	-0.032*	-0.032*	-0.019*	-0.028*	-0.104*	0.181*	-0.050*	-0.321*	0.023*	0.070*	1.000			
(25) Credit card loan	-0.035*	0.008*	0.147*	0.003	-0.035*	0.415*	0.154*	0.008*	-0.032*	0.012*	-0.034*	-0.035*	0.003*	-0.013*	-0.013*	-0.017*	-0.023*	0.160*	0.101*	0.054*	-0.152*	0.034*	0.144*	0.405*	1.000		
(26) GDP	0.008*	0.001	0.001	-0.001	0.025*	0.006*	0.004*	0.039*	-0.078*	0.011*	0.043*	-0.088*	0.015*	-0.005*	-0.005*	0.028*	0.034*	-0.005*	0.029*	-0.021*	-0.018*	0.003*	-0.000	0.012*	0.007*	1.000	
(27) HPI	0.032*	0.010*	-0.009*	0.015*	0.108*	0.043*	0.008*	0.296*	-0.557*	0.121*	0.225*	-0.514*	0.115*	-0.017*	-0.016*	0.360*	0.340*	-0.000	0.127*	-0.094*	-0.048*	0.019*	-0.046*	0.030*	-0.001	0.151*	1.000
(28) UNEMP	-0.009*	0.056*	-0.012*	-0.003	-0.032*	0.020*	0.003	-0.107*	0.228*	-0.061*	-0.092*	0.212*	-0.055*	-0.005*	-0.005*	-0.031*	-0.027*	0.016*	-0.032*	0.033*	0.019*	0.022*	-0.016*	-0.016*	-0.018*	-0.090*	-0.157*

Table 4: Bank capital and Liquidity risk: Market crisis period

This table reports the results for the impact of bank capital on liquidity risk over normal and market crisis periods. Market crisis includes long-term capital management 1998Q3-1998Q4, the bursting of the dot-com bubble and 9/11 terrorist attack 2000Q2-2002Q3. Crisis takes a value of 1 for these periods and otherwise 0. We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEV × normal	-0.001***	0.0012***	-0.0002***	0.0002***	-0.002***	0.001***	0.0003***
	(0.0001)	(0.0001)	(0.00002)	(0.00011)	(0.0001)	(0.0001)	(0.0001)
LEV × crisis	-0.001***	0.002***	-0.0003***	0.0004***	-0.002***	0.001***	0.0006***
	(0.0001)	(0.0001)	(0.00004)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Intercept	0.437***	0.214***	-0.028***	-0.143***	0.628***	0.171***	-0.145***
	(0.0097)	(0.007)	(0.004)	(0.016)	(0.013)	(0.017)	(0.013)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	973546	973546	973546	918587	918587	962485	882344
R-squared	0.23990	0.17992	0.03019	0.15179	0.25939	0.12811	0.05093

We can show all the control variables in the first Table and discuss the same and in subsequent columns we can only mention that we are using the same control variables and results are broadly consistent. That was the comment as well from one of the referees.

Table 5 Bank capital and Liquidity risk: Bank crisis period

This table reports the results for the impact of bank capital on liquidity risk over normal and bank crisis periods. Takes the value of one during sub-prime lending crisis 2007Q3-2009Q4. Crisis takes a value of 1 for this period and 0 otherwise. We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Assets		**Liabilities**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEV × normal	-0.001***	0.001***	-0.0003***	0.0002*	-0.002***	0.001***	0.0004***
	(0.0001)	(0.0001)	(0.00002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LEV × bkcrisis	-0.0012***	0.002***	-0.0002***	-0.0004***	-0.002***	0.002***	0.0004***
	(0.0001)	(0.0001)	(0.00004)	(0.0002)	(0.0001)	(0.0002)	(0.0001)
Intercept	0.446***	0.203***	-0.027***	-0.137***	0.638***	0.156***	-0.148***
	(0.010)	(0.008)	(0.004)	(0.017)	(0.013)	(0.017)	(0.013)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	973546	973546	973546	918587	918587	962485	882344
R-squared	0.24077	0.18169	0.03025	0.15184	0.26009	0.12932	0.05098

Table 6: Bank capital and Liquidity risk- Covid-19 analysis

This table reports the results for the impact of bank capital on liquidity risk. Covid-19 is a dummy variable and takes the value of one from the period Q1-2021- Q4 2021. We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed funds sold	Fed funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEV×normal	-0.001***	0.00118***	-0.0003***	0.0003**	-0.002***	0.0008***	0.0003***
	(0.0001)	(0.00006)	(0.00002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LEV×Covid19	0.001***	-0.001***	0.0003***	-0.001***	-0.00027	-0.005	-0.001***
	(0.0003)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0004)	(0.0003)
Intercept	0.270***	0.212***	-0.021***	-0.156***	0.388***	0.041***	-0.138***
	(0.008)	(0.006)	(0.003)	(0.013)	(0.011)	(0.014)	(0.011)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	973546	973546	973546	918587	918587	962485	882344
R-squared	0.23925	0.17732	0.02883	0.15144	0.25727	0.12779	0.05075

Table 7: Bank capital and Liquidity risk- TARP and Intervention

This table reports the results for the impact of bank capital on liquidity risk. TARP = Takes the value of one when a bank receive capital supports and have not repaid in full. TARP program is considered as the main source of government capital support for banks. INTV = Takes the value of one during regulatory interventions. The main regulatory interventions considered include 2004Q1-2004Q3 the exemption of special purpose vehicle on consolidation and the 2004Q3-2005Q3 changes of the net capital rule by the SEC. We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed funds sold	Fed funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEV×TARP	0.001**	-0.002***	-0.000	-0.00004	0.0013**	-0.003***	-0.0005**
	(0.0005)	(0.0003)	(0.0001)	(0.001)	(0.001)	(0.001)	(0.0002)
LEV×INTV	-0.001***	0.001***	-0.0001***	0.0002	-0.001***	-0.00004	0.0001
	(0.0001)	(0.0001)	(0.00004)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Intercept	0.398***	0.260***	-0.039***	-0.133***	0.557***	0.202***	-0.132***
	(0.009)	(0.007)	(0.004)	(0.0150)	(0.012)	(0.016)	(0.012)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	973546	973546	973546	918587	918587	962485	882344
R-squared	0.23621	0.17314	0.02853	0.15161	0.24712	0.12722	0.05013

Table 8: Analysis around the adoption of LCR: DiD analysis

The table shows results from regressions for the [-2,+3] window around the treatment year (t=1) of 2013. We have two groups of treated banks, sorted by size as of *t-1* (2011): *Large >$250B*, banks with assets in excess of $250B and *Large $50-$250B*, banks with assets between $50B and $250B. The control group includes banks with assets below $50B. *Post* is an indicator variable equal to one starting in 2013. *Pre* is an indicator equal to one for 2011 and zero otherwise. Bank capital represents either leverage ratio (see columns 1-7) or Tier 1 ratio (see columns 7-14). We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Leverage Ratio						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Federal funds sold	Federal funds purchased	Money market deposits	Demand deposits	Unused commitments	Derivatives
Pre × Large $50B-$250B	0.00093	-0.00432	0.00202	0.00256	0.00721**	-0.00840	0.00645
	(0.00530)	(0.00311)	(0.00294)	(0.00890)	(0.00308)	(0.00972)	(0.00890)
Post × Large $50B-$250B	0.00053	0.00453	0.00105	0.00537	0.00555	0.00421	-0.01740*
	(0.00575)	(0.00446)	(0.00271)	(0.00510)	(0.00502)	(0.00754)	(0.00896)
Pre × Large > $250B	-0.01913**	0.00129	0.00597**	0.00759	0.01046***	-0.01436	-0.00852
	(0.00853)	(0.00350)	(0.00277)	(0.01054)	(0.00366)	(0.01348)	(0.00562)
Post × Large > $250B	-0.00133	-0.00061	-0.00160	0.01398***	0.00382	-0.00706	-0.00946
	(0.00672)	(0.00279)	(0.00220)	(0.00517)	(0.00295)	(0.01239)	(0.00727)
Large > $250B	0.06340*	0.00481	-0.01037**	-0.0321***	0.03031	-0.00100	0.01395
	(0.03420)	(0.00821)	(0.00449)	(0.01052)	(0.02542)	(0.02909)	(0.01070)
Intercept	0.37961***	0.01681	0.00541	0.09525**	0.15662***	0.00011	-0.1152***
	(0.02955)	(0.01633)	(0.00767)	(0.04268)	(0.03253)	(0.03426)	(0.03353)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
NOBS	168121	168121	168121	168121	168121	168120	162542
R^2	0.20520	0.04794	0.01066	0.08071	0.27592	0.08454	0.01831
Bank Fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES

Table 9 Alternative Independent Variables (Robustness Tests)

This table reports the results for the impact of bank capital on liquidity risk over normal and market crisis periods. Market crisis includes long-term capital management 1998Q3-1998Q4, the bursting of the dot-com bubble and 9/11 terrorist attack 2000Q2-2002Q3. Crisis takes a value of 1 for these periods and otherwise 0. We include bank and year fixed effects in all specifications. Standard errors (reported in parentheses) are robust to heteroskedasticity and are clustered at the bank-level. Variable definitions are available in Table 1. ***, **, * statistical significance at the 1%, 5%, 10% levels; respectively.

	Panel A- Bank capital and Liquidity risk: Market crisis period						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT ×normal	-0.00004	0.0005***	-0.0001***	-0.00002	-0.0007***	0.0002***	0.0001***
	(0.00004)	(0.00003)	(0.00001)	(0.00005)	(0.00004)	(0.00005)	(0.00003)
TOT × crisis	-0.0002***	0.0008***	-0.0001***	0.0001**	-0.0009***	0.0002**	0.0003***
	(0.00005)	(0.00005)	(0.00002)	(0.00006)	(0.00006)	(0.00008)	(0.00004)
Intercept	0.403***	0.221***	-0.031***	-0.124***	0.621***	0.185***	-0.142***
	(0.010)	(0.008)	(0.004)	(0.016)	(0.013)	(0.017)	(0.013)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	962485	962485	962485	907545	907545	962485	882344
R-squared	0.22657	0.17994	0.03013	0.15220	0.23953	0.12719	0.05058
	Panel B- Bank capital and Liquidity risk: Bank crisis period						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT × normal	-0.0001	0.0006***	-0.0001***	-0.0001	-0.001***	0.0003***	0.0002***
	(0.00004)	(0.00004)	(0.00001)	(0.0001)	(0.0001)	(0.0001)	(0.00003)
TOT × bkcrisis	-0.0002**	0.001***	-0.0002***	-0.0002***	-0.001***	0.001***	0.0003***
	(0.0001)	(0.0001)	(0.00002)	(0.00007)	(0.0001)	(0.0001)	(0.0001)
Intercept	0.406***	0.204***	-0.029***	-0.117***	0.628***	0.172***	-0.147***
	(0.010)	(0.008)	(0.004)	(0.017)	(0.014)	(0.017)	(0.013)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	962485	962485	962485	907545	907545	962485	882344
R-squared	0.22657	0.18191	0.03054	0.15231	0.23915	0.12780	0.05086
	Panel C- Bank capital and Liquidity risk- Covid-19 analysis						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT×normal	-0.00003	0.00040***	-0.0001***	-0.00003	-0.001***	0.0002***	0.0001***
	(0.00004)	(0.00003)	(0.00001)	(0.00004)	(0.00004)	(0.00005)	(0.00003)
TOT× Covid19	0.001***	-0.001***	0.00022***	-0.001***	0.00028**	0.00005	-0.001***
	(0.00015)	(0.00009)	(0.00003)	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Intercept	0.236***	0.222***	-0.023***	-0.143***	0.375***	0.053***	-0.134***
	(0.007)	(0.006)	(0.003)	(0.014)	(0.010)	(0.014)	(0.010)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	962485	962485	962485	907545	907545	962485	882344
R-squared	0.22657	0.17688	0.02872	0.15191	0.23750	0.12693	0.05057
	Panel D- Bank capital and Liquidity risk- TARP and Intervention						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT×TARP	0.001***	-0.002***	-0.00001	-0.0001	0.001**	-0.002***	-0.0003**
	(0.0004)	(0.0003)	(0.0001)	(0.0005)	(0.0004)	(0.0004)	(0.0001)
TOT×INTV	-0.0004***	0.0004***	-0.0001***	0.00002	-0.0003***	-0.0003***	0.0001***
	(0.0001)	(0.0001)	(0.00001)	(0.0001)	(0.0001)	(0.0001)	(0.00004)
Intercept	0.402***	0.257***	-0.041***	-0.126***	0.564***	0.204***	-0.133***

	(0.010)	(0.008)	(0.004)	(0.015)	(0.013)	(0.016)	(0.012)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Obs.	962485	962485	962485	907545	907545	962485	882344
R-squared	0.22703	0.17558	0.02882	0.15218	0.23186	0.12731	0.05022
	Panel- E Analysis around the adoption of LCR: DiD analysis						
	Asset Side		**Liability Side**			**Off-B/S**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Federal funds sold	Federal funds purchased	Money market deposits	Demand deposits	Unused commitments	Derivatives
Pre × Large $50B-$250B	-0.00096	-0.00434	0.00194	0.00200	0.00634**	-0.00867	0.00635
	(0.00531)	(0.00310)	(0.00294)	(0.00891)	(0.00298)	(0.00978)	(0.00890)
Post × Large $50B-$250B	0.00068	0.00451	0.00103	0.00525	0.00545	0.00438	-0.01739*
	(0.00574)	(0.00444)	(0.00269)	(0.00512)	(0.00498)	(0.00755)	(0.00895)
Pre × Large > $250B	-0.02064**	0.00125	0.00588**	0.00697	0.00960***	-0.01443	-0.00859
	(0.00836)	(0.00348)	(0.00279)	(0.01051)	(0.00359)	(0.01332)	(0.00562)
Post × Large > $250B	-0.00205	-0.00065	-0.00167	0.01353***	0.00328	-0.00696	-0.00949
	(0.00701)	(0.00278)	(0.00223)	(0.00509)	(0.00291)	(0.01221)	(0.00728)
Large > $250B	0.06927**	0.00514	-0.00984**	-0.0287***	0.03468	-0.00163	0.01422
	(0.03481)	(0.00816)	(0.00454)	(0.00957)	(0.02434)	(0.02843)	(0.01073)
Intercept	0.22848***	0.02015	0.00397	0.07813*	0.11543***	-0.04673	-0.1228***
	(0.02993)	(0.01623)	(0.00744)	(0.04485)	(0.03301)	(0.03439)	(0.03543)
Bank and macro controls	YES	YES	YES	YES	YES	YES	YES
NOBS	168120	168120	168120	168120	168120	168120	162542
R^2	0.20288	0.04809	0.01072	0.08018	0.27344	0.08708	0.01830
Bank Fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy	YES	YES	YES	YES	YES	YES	YES

Online Appendix

Appendix A1 Leverage ratio, market crisis, split by size

SMALL BANKS (ASSET<100,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR-normal	-0.001***	0.00128***	-0.00018***	-0.00003	-0.00181***	0.00082***	0.00019***
	(0.00008)	(0.00007)	(0.00002)	(0.00010)	(0.00010)	(0.00011)	(0.00005)
LEVR-mktcrisis	-0.001***	0.00155***	-0.00015***	0.00006	-0.00191***	0.00061***	0.00031***
	(0.00012)	(0.00011)	(0.00004)	(0.00013)	(0.00012)	(0.00019)	(0.00007)
Intercept	0.43806***	0.24114***	-0.02530***	-0.09872***	0.58618***	0.19855***	-0.09080***
	(0.01138)	(0.00832)	(0.00344)	(0.01631)	(0.01372)	(0.01575)	(0.00976)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	900378	900378	900378	850196	850196	890203	818198
R-squared	0.24539	0.18341	0.02291	0.11960	0.28436	0.11774	0.02790

MEDIUMBANKS(ASSET>100,000AND<300,000)							
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR-normal	-0.001***	0.00028	-0.00054***	-0.00153**	-0.00067**	-0.00088	-0.00049
	(0.00036)	(0.00029)	(0.00018)	(0.00068)	(0.00027)	(0.00062)	(0.00078)
LEVR-mktcrisis	-0.002***	0.00045	-0.00085***	-0.00127*	-0.00057	-0.00136	-0.00003
	(0.00052)	(0.00059)	(0.00028)	(0.00065)	(0.00043)	(0.00107)	(0.00171)
Intercept	0.44838***	0.06309*	-0.12491***	0.30885**	0.46949***	0.10332	-0.38252**
	(0.06056)	(0.03628)	(0.03603)	(0.12399)	(0.07527)	(0.14236)	(0.17459)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	43332	43332	43332	40450	40450	42583	37838
R-squared	0.23050	0.07631	0.08924	0.22582	0.15292	0.16644	0.06391

LARGEBANKS(ASSETS>300,000)							
	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR--normal	0.00025	0.00023	-0.001***	-0.00016	0.00060	-0.00019	-0.00283**
	(0.00046)	(0.00028)	(0.00031)	(0.00080)	(0.00046)	(0.00076)	(0.00113)
LEVR--mktcrisis	-0.00032	0.00067	-0.001***	0.00023	0.00078	0.00069	-0.00210
	(0.00043)	(0.00055)	(0.00042)	(0.00097)	(0.00048)	(0.00105)	(0.00161)
Intercept	0.39553***	0.10009*	-0.340***	0.40292**	0.50549***	0.22112	-0.38168**
	(0.07286)	(0.05372)	(0.05667)	(0.16053)	(0.09468)	(0.16418)	(0.18992)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29836	29836	29836	27941	27941	29699	26308
R-squared	0.18533	0.09301	0.27231	0.36061	0.20914	0.28558	0.15294

Appendix A2 Total capital ratio, market crisis, split by size

SMALL BANKS (ASSET<100,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT-normal	-0.00007*	0.00048***	-0.00009***	-0.00009**	-0.00071***	0.00022***	0.00007***
	(0.00004)	(0.00003)	(0.00001)	(0.00005)	(0.00004)	(0.00005)	(0.00002)
TOT-mktcrisis	-0.0002***	0.00078***	-0.00009***	-0.00004	-0.00080***	0.00015**	0.00012***
	(0.00005)	(0.00005)	(0.00002)	(0.00006)	(0.00006)	(0.00008)	(0.00004)
Intercept	0.40232***	0.25314***	-0.02604***	-0.08628***	0.57804***	0.21457***	-0.08896***
	(0.01187)	(0.00880)	(0.00355)	(0.01630)	(0.01403)	(0.01535)	(0.00963)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	890203	890203	890203	840031	840031	890203	818198
R-squared	0.23253	0.18408	0.02290	0.11962	0.26479	0.11687	0.02779

MEDIUMBANKS(ASSET>100,000AND<300,000)							
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT-normal	0.00063**	-0.00025**	-0.00026**	-0.00108***	-0.00006	-0.00018	-0.00074*
	(0.00025)	(0.00011)	(0.00011)	(0.00038)	(0.00017)	(0.00032)	(0.00042)
TOT-mktcrisis	0.00003	-0.00011	-0.001***	-0.00078	-0.00032	-0.00023	-0.00074
	(0.00035)	(0.00019)	(0.00016)	(0.00053)	(0.00026)	(0.00057)	(0.00070)
Intercept	0.3649***	0.09221**	-0.13***	0.339***	0.471***	0.088	-0.345**
	(0.057)	(0.036)	(0.037)	(0.124)	(0.078)	(0.145)	(0.174)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	42583	42583	42583	39706	39706	42583	37838
R-squared	0.22046	0.07754	0.08920	0.23149	0.15562	0.16568	0.06516

LARGEBANKS(ASSETS>300,000)							
	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT--normal	0.00129**	0.00022	-0.001***	-0.00048	0.00072	-0.002***	-0.00016
	(0.00054)	(0.00035)	(0.00017)	(0.00041)	(0.00063)	(0.00054)	(0.00053)
TOT--mktcrisis	-0.00028	0.00025	-0.001***	0.00074	-0.00002	-0.00087	0.00013
	(0.00033)	(0.00042)	(0.00030)	(0.00079)	(0.00036)	(0.00101)	(0.00074)
Intercept	0.31819***	0.08965*	-0.323***	0.42420***	0.47555***	0.33492*	-0.43184**
	(0.06533)	(0.05384)	(0.05725)	(0.16378)	(0.08047)	(0.17416)	(0.20563)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29699	29699	29699	27808	27808	29699	26308
R-squared	0.19903	0.09365	0.27293	0.36182	0.21347	0.29061	0.14886

Appendix A3 Leverage ratio, bank crisis, split by size

SMALL BANKS (ASSET<100,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR-normal	-0.001***	0.00139***	-0.00018***	-0.00015	-0.00190***	0.00102***	0.00021***
	(0.00008)	(0.00007)	(0.00002)	(0.00011)	(0.00010)	(0.00012)	(0.00005)
LEVR-bkcrisis	-0.001***	0.00164***	-0.00011***	-0.00078***	-0.00145***	0.00177***	0.00030***
	(0.00013)	(0.00010)	(0.00003)	(0.00015)	(0.00012)	(0.00018)	(0.00008)
Intercept	0.44912***	0.22747***	-0.02459***	-0.08791***	0.59651***	0.17799***	-0.09303***
	(0.01163)	(0.00851)	(0.00350)	(0.01670)	(0.01401)	(0.01596)	(0.01006)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	900378	900378	900378	850196	850196	890203	818198
R-squared	0.24624	0.18512	0.02293	0.11998	0.28482	0.11925	0.02800

MEDIUMBANKS(ASSET>100,000AND<300,000)							
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR-normal	-0.001***	0.00025	-0.001***	-0.00179**	-0.001**	-0.001	-0.001
	(0.00036)	(0.00028)	(0.00018)	(0.00074)	(0.00028)	(0.001)	(0.001)
LEVR-bkcrisis	-0.001***	0.00009	-0.001***	-0.00172**	0.00028	0.001	-0.002
	(0.00036)	(0.00037)	(0.00028)	(0.00075)	(0.00034)	(0.001)	(0.001)
Intercept	0.45726***	0.06351*	-0.119***	0.32767***	0.464***	0.084	-0.362**
	(0.06156)	(0.03640)	(0.03648)	(0.12564)	(0.07645)	(0.141)	(0.17421)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	43332	43332	43332	40450	40450	42583	37838
R-squared	0.23062	0.07615	0.08971	0.22653	0.15288	0.16659	0.06494

LARGEBANKS(ASSETS>300,000)							
	(15)	(16)	(17)	(18)	(19)	(20)	(21)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
LEVR--normal	0.00009	0.00028	-0.001***	-0.00011	0.00063	-0.00026	-0.00317***
	(0.00049)	(0.00027)	(0.00034)	(0.00082)	(0.00047)	(0.00079)	(0.00119)
LEVR--bkcrisis	-0.00106*	0.00061	-0.00100*	0.00040	0.00046	-0.00011	-0.00347**
	(0.00059)	(0.00039)	(0.00054)	(0.00090)	(0.00038)	(0.00100)	(0.00141)
Intercept	0.40260***	0.09737*	-0.336***	0.40062**	0.50402***	0.22387	-0.36326*
	(0.07288)	(0.05369)	(0.05617)	(0.15990)	(0.09511)	(0.16281)	(0.18683)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29836	29836	29836	27941	27941	29699	26308
R-squared	0.18633	0.09340	0.27296	0.36065	0.20917	0.28555	0.15465

Appendix A4 Total capital ratio, bank crisis, split by size

SMALL BANKS (ASSET<100,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT-normal	-0.00008*	0.00055***	-0.00010***	-0.00016***	-0.00073***	0.00031***	0.00009***
	(0.00004)	(0.00004)	(0.00001)	(0.00005)	(0.00005)	(0.00005)	(0.00003)
TOT-bkcrisis	-0.00016**	0.00086***	-0.00012***	-0.00037***	-0.00047***	0.00060***	0.00016***
	(0.00007)	(0.00006)	(0.00002)	(0.00007)	(0.00006)	(0.00009)	(0.00004)
Intercept	0.40538***	0.23553***	-0.02320***	-0.07469***	0.58412***	0.19739***	-0.09228***
	(0.01218)	(0.00902)	(0.00363)	(0.01680)	(0.01444)	(0.01561)	(0.00997)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	890203	890203	890203	840031	840031	890203	818198
R-squared	0.23256	0.18586	0.02321	0.12000	0.26435	0.11764	0.02795

MEDIUM BANKS (ASSET>100,000 AND <300,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT-normal	0.00078***	-0.00024**	-0.00031***	-0.00117***	0.00004	0.00001	-0.00075
	(0.00027)	(0.00012)	(0.00010)	(0.00044)	(0.00020)	(0.00037)	(0.00047)
TOT-bkcrisis	0.00072***	-0.00003	-0.00041**	-0.00062	0.00035	0.00079*	-0.00048
	(0.00027)	(0.00022)	(0.00017)	(0.00045)	(0.00024)	(0.00046)	(0.00080)
Intercept	0.34497***	0.09231**	-0.12241***	0.35331***	0.45870***	0.06425	-0.33966*
	(0.05767)	(0.03682)	(0.03767)	(0.12837)	(0.08089)	(0.14585)	(0.17714)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	42583	42583	42583	39706	39706	42583	37838
R-squared	0.22150	0.07752	0.08928	0.23158	0.15577	0.16608	0.06509

LARGE BANKS (ASSETS>300,000)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash	Fed Funds sold	Fed Funds purchased	Money market deposit	Demand deposit	Unused commitments	Derivatives
TOT-normal	0.00143**	0.00031	-0.00059***	-0.00046	0.00087	-0.00188***	-0.00012
	(0.00060)	(0.00030)	(0.00017)	(0.00045)	(0.00065)	(0.00065)	(0.00054)
TOT-bkcrisis	0.00077	0.00063	-0.00036	0.00036	0.00094***	-0.00133	0.00046
	(0.00070)	(0.00047)	(0.00026)	(0.00054)	(0.00035)	(0.00160)	(0.00068)
Intercept	0.30770***	0.08483	-0.32633***	0.42569***	0.46466***	0.34221*	-0.43488**
	(0.06488)	(0.05299)	(0.05710)	(0.16372)	(0.08031)	(0.17543)	(0.20483)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29699	29699	29699	27808	27808	29699	26308
R-squared	0.19997	0.09480	0.27257	0.36177	0.21504	0.29115	0.14891

Appendix A5 Leverage ratio, TARP, Intervention, split by size

	SMALL BANKS (ASSET<100,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
LEVR_TARP	0.00108**	-0.00237***	-0.00005	-0.00006	0.00155**	-0.00324***	-0.00043**
	(0.00049)	(0.00036)	(0.00009)	(0.00074)	(0.00066)	(0.00057)	(0.00021)
LEVR_INT	-0.00081***	0.00089***	-0.00011***	0.00001	-0.00068***	0.00003	0.00012
	(0.00011)	(0.00012)	(0.00003)	(0.00013)	(0.00012)	(0.00018)	(0.00008)
Intercept	0.39270***	0.29460***	-0.03284***	-0.10001***	0.50998***	0.23352***	-0.08290***
	(0.01030)	(0.00803)	(0.00320)	(0.01483)	(0.01251)	(0.01500)	(0.00899)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	900378	900378	900378	850196	850196	890203	818198
R-squared	0.24192	0.17709	0.02213	0.11959	0.27410	0.11681	0.02759

	MEDIUMBANKS(ASSET>100,000AND<300,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
LEVR_TARP	-0.00154	0.00038**	0.00050	0.00224	-0.00195*	-0.00320	0.00002
	(0.00107)	(0.00017)	(0.00042)	(0.00334)	(0.00105)	(0.00204)	(0.00048)
LEVR_INT	-0.00108***	0.00026	-0.00002	0.00002	-0.001***	-0.001	-0.001
	(0.00040)	(0.00029)	(0.00018)	(0.00071)	(0.00024)	(0.00084)	(0.00078)
Intercept	0.412***	0.072**	-0.142***	0.2638**	0.450***	0.076	-0.395**
	(0.062)	(0.034)	(0.036)	(0.121)	(0.074)	(0.146)	(0.172)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	43332	43332	43332	40450	40450	42583	37838
R-squared	0.22711	0.07590	0.08691	0.22350	0.15235	0.16611	0.06383

	LARGEBANKS(ASSETS>300,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
LEVR_TARP	0.00213	-0.00096	0.00054	-0.00383	0.00163	-0.00662*	0.00091
	(0.00432)	(0.00129)	(0.00035)	(0.00348)	(0.00303)	(0.00389)	(0.00161)
LEVR_INT	-0.00009	0.00018	-0.00026	-0.00042	0.00007	-0.00183***	-0.00345**
	(0.00070)	(0.00031)	(0.00042)	(0.00120)	(0.00036)	(0.00060)	(0.00138)
Intercept	0.400***	0.105*	-0.362***	0.40327**	0.518***	0.227	-0.433**
	(0.07605)	(0.05537)	(0.05782)	(0.16139)	(0.09859)	(0.16803)	(0.19812)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29836	29836	29836	27941	27941	29699	26308
R-squared	0.18555	0.09282	0.26891	0.36109	0.20841	0.28708	0.15054

Appendix A6 Total capital ratio, TARP, Intervention, split by size

	SMALL BANKS (ASSET<100,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
TOT_TARP	0.00101***	-0.0016***	-0.00003	-0.00007	0.00110**	-0.00205***	-0.00027*
	(0.00038)	(0.00029)	(0.00006)	(0.00051)	(0.00044)	(0.00040)	(0.00014)
TOT_INT	-0.00033***	0.00034***	-0.0001***	-0.00006	-0.0003***	-0.00021***	0.00007**
	(0.00005)	(0.00005)	(0.00001)	(0.00005)	(0.00005)	(0.00008)	(0.00003)
Intercept	0.39865***	0.29447***	-0.034***	-0.094***	0.5170***	0.23544***	-0.083***
	(0.01103)	(0.00852)	(0.00328)	(0.01515)	(0.01316)	(0.01500)	(0.00898)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	890203	890203	890203	840031	840031	890203	818198
R-squared	0.23293	0.17979	0.02202	0.11953	0.25723	0.11685	0.02760

	MEDIUMBANKS(ASSET>100,000AND<300,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
TOT_TARP	-0.00097	0.00019	0.00018	0.00127	-0.00130**	-0.00109	0.00005
	(0.00069)	(0.00015)	(0.00025)	(0.00189)	(0.00056)	(0.00168)	(0.00036)
TOT_INT	-0.00096***	0.00010	-0.00026*	0.00015	-0.00041**	-0.00072	0.00001
	(0.00033)	(0.00021)	(0.00014)	(0.00052)	(0.00019)	(0.00065)	(0.00043)
Intercept	0.408***	0.075**	-0.149***	0.262**	0.466***	0.075	-0.396**
	(0.06018)	(0.03512)	(0.03629)	(0.12312)	(0.07457)	(0.14648)	(0.17246)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	42583	42583	42583	39706	39706	42583	37838
R-squared	0.21817	0.07638	0.08765	0.22792	0.15596	0.16589	0.06366

	LARGEBANKS(ASSETS>300,000)						
	(1) Cash	(2) Fed Funds sold	(3) Fed Funds purchased	(4) Money market deposit	(5) Demand deposit	(6) Unused commitments	(7) Derivatives
TOT_TARP	0.00239	-0.00095	0.00040**	-0.00290	0.00190	-0.00529**	0.00073
	(0.00311)	(0.00100)	(0.00020)	(0.00265)	(0.00197)	(0.00228)	(0.00124)
TOT_INT	-0.00020	0.00017	-0.00012	0.00052	-0.00010	-0.00125**	0.00047
	(0.00054)	(0.00031)	(0.00019)	(0.00034)	(0.00020)	(0.00055)	(0.00093)
Intercept	0.402***	0.104*	-0.364***	0.394**	0.523***	0.223	-0.444**
	(0.07618)	(0.05537)	(0.05797)	(0.16234)	(0.09881)	(0.16805)	(0.19880)
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES
Qrtly dummy:qrt1993Q1-qrt2020Q2	YES	YES	YES	YES	YES	YES	YES
Obs.	29699	29699	29699	27808	27808	29699	26308
R-squared	0.18641	0.09343	0.26908	0.36180	0.21007	0.28757	0.14890