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Abstract

We find that, relative to other banks, those subject to the Liquidity Coverage Ratio (LCR) reduce lending and liquidity creation but also contribute less to fire-sale externalities. For LCR banks, we estimate that the total after-tax benefits of reduced fire-sale risk (net of the costs associated with foregone lending) exceed $50 billion from 2013:Q2 to 2017, mostly accruing to the largest LCR banks. Non-LCR regulations enacted during our sample period cannot fully account for these findings. Our results highlight the trade-off between liquidity creation and resilience arising from liquidity regulations, and how it varies for banks of different sizes.

Key words: liquidity coverage ratio, banks, liquidity creation, lending, systemic risk

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1 Introduction

Perhaps due to their relative novelty (e.g., US regulators released the final version of the Liquidity Coverage Ratio (LCR) in September 2014), liquidity regulations have received far less attention in the academic literature than capital regulations. As the LCR imposes a floor on the ratio of liquid assets to expected outflows from runnable liabilities, banks have incentives to adjust the compositions of their assets and liabilities when responding to it. The costs and benefits of LCR depend on the exact nature of these adjustments. For example, if banks primarily adjust by holding more liquid assets, then lending, liquidity creation, and fire-sale risk are all likely to decrease. If banks instead focus on increasing their stable funding, they may have less need to cut lending and liquidity creation.

There is empirical evidence for both asset- and liability-side adjustments to liquidity regulations. Studies of national rules that resemble LCR show that banks satisfy the requirements by increasing the share of stable deposits instead of reducing lending (BIS (2016) and Banerjee and Mio (2018)), but calibrations of macro-finance models suggest that liquidity regulations may lower lending and output (see BIS (2021) for a summary). Of theoretical studies, Perotti and Suarez (2011) and Kashyap, Tsomocos and Vardoulakis (2020) each conclude that liquidity regulations limit credit expansion. Regarding fire-sale risk, Carletti, Goldstein and Leonello (2020) argue that increasing liquidity reduces the extent of costly fire-sales although regulators may choose not to eliminate fire sales if the cost of liquidity is too high. Conversely, Cecchetti and Kashyap (2018) note that fire-sale risk may *increase* if LCR banks have similar, correlated exposures.

Motivated by these considerations, we study how US banks subject to the LCR adjust their balance sheet mixes – in particular, their lending – and, using the measure introduced by Berger and Bouwman (2009), the implications for asset- and liability-side liquidity creation. In doing so, we account for a wide range of non-LCR regulations implemented during our sample period. Further, we examine changes in fire-sale risk of LCR banks arising from changes in the concentration of illiquid assets. Because we find that covered banks both reduce lending and contribute less to fire-sale risk, we also quantify the net benefits of LCR.

The LCR requires internationally active bank holding companies (BHCs or simply "banks") with assets of $50 billion or over (LCR banks) to hold enough high quality liquid assets (HQLA) to cover 30 days of expected net cash outflows during a stress event. To identify LCR effects, we examine changes in outcomes for LCR banks relative to midsized banks exempt from the LCR (non-LCR banks) since 2013Q2, the quarter after Basel LCR rules were finalized. Thus, we use the term "*after LCR*" to mean "*after the finalization of LCR*." In placebo tests that use arbitrary size groupings and event dates, we show that the estimated effects mostly obtain at the $50 billion cutoff or higher and around 2013Q1. We also provide evidence of parallel pre-trends across control and treatment groups. Finally, we exploit heterogeneity *within* LCR banks with respect to their pre-LCR holdings of liquid assets and runnable liabilities.

We find that covered banks subject to LCR decrease their illiquid assets as shares of total assets, resulting in decreased asset-side liquidity creation, relative to non-LCR banks. LCR banks also reduce their dependence on liquid borrowings, and so their overall liquidity creation declines relative to non-LCR banks, consistent with Donaldson, Piacentino and Thakor (2018). Since banks can comply with LCR by increasing stable funding or cutting loans, they have incentives to exploit synergies between the two sides of their balance sheets. Consistent with this idea, we find that large LCR banks with lower *pre-LCR* shares of stable funding decrease their loan shares by less *after LCR*, indicating a credit insurance effect of stable deposits (Berlin and Mester (1999), Ivashina and Scharfstein (2010) and Cornett, McNutt, Strahan and Tehranian (2011)).

LCR banks shed illiquid assets mostly by cutting lending relative to non-LCR banks. Changes in LCR banks' securitization activity (Maddaloni and Peydró (2011)) cannot explain these results. Regulated banks also tighten lending standards or terms more frequently than exempt banks after LCR – a decision that they are more likely to attribute to regulation or supervision in the Federal Reserve Board's Senior Loan Officers' Opinion Survey (SLOOS).

Thus, the evidence indicates that the LCR leads to a reduction in credit supply.

A slew of other regulations were enacted during our sample period, such as stress tests, changes in risk-weights from capital rules and leverage ratios, and enhanced supervision. By exploiting differences in implementations between LCR and non-LCR regulations, we argue that the estimated lending effects cannot be fully ascribed to these other regulations. In particular, asset holdings of LCR banks respond to LCR haircuts even when there are no changes in the corresponding risk weights imposed by capital rules. Also, lending reductions by LCR banks mostly occur independent of participation in stress tests, borrower size and G-SIB designations. Finally, evidence based on differences in the incidence of LCR and non-LCR regulations on banks of various sizes are consistent with incremental LCR effects.

We next consider the effects of LCR on fire-sale risk. Using estimates by Duarte and Eisenbach (2021), we find that the illiquidity component of fire-sale risk decreases by more for covered banks than for exempt banks in the post-LCR period. In other words, fire-sale externalities arising from a concentration of illiquid assets is lower for banks subject to LCR, as intended by regulators. Since capital regulations are unlikely to substantially affect illiquidity linkages, this result is compelling evidence of an LCR effect.

Since LCR banks reduce their lending shares following LCR, they incur an opportunity cost of foregone lending that partially offsets the benefits associated with lower fire-sale externalities. We estimate that the *net* after-tax benefits from LCR, aggregated over all LCR banks, exceed $50 billion from 2013Q2 to 2017. Notably, smaller LCR banks with assets less than $250 billion account for less than 7% of net benefits. This evidence supports recent actions by US regulators to exempt some of these smaller banks from LCR.[1]

This paper has three contributions. First, consistent with theoretical insights, we show how banks utilize synergies between their assets and liabilities in responding to LCR (Calomiris, Heider and Hoerova (2018), Carletti et al. (2020) and Kashyap et al. (2020)). We further

[1]After the passage of Senate Bill 2155 on May 24, 2018, BHCs with assets between $50 billion and $100 billion are no longer subject to LCR. Senate Bill 2155. Reubenstein and Sarkar (2021) evaluate these changes. Further relaxations to LCR were made in December 2019.

map changes in the composition of bank assets and liabilities to liquidity creation by LCR banks. Second, unlike papers that document only the costs of regulations, we quantify the net benefits from reduced fire-sale externalities and bank lending. In estimating fire-sale risk, we focus on its illiquidity component, thereby analyzing a channel proposed in the theoretical literature (e.g., Carletti et al. (2020)). Third, our paper is, to the best of our knowledge, the first to show (based on novel identifications) lower lending *and* tighter lending standards of LCR banks, relative to exempt banks, that is incremental to effects from capital regulations.

The paper is organized as follows. Section 2 provides background on LCR and section 3 reviews the literature and develops hypotheses. In section 4, we discuss the data and our methodology. We investigate the effects of LCR on bank balance sheets and lending standards in sections 5 and 6, respectively. In section 7, we study bank liquidity creation. In section 8, we examine changes in the fire-sale externalities of LCR banks and quantify the net benefits from LCR. Section 9 concludes. We present several additional results in the internet appendix (denoted simply as "appendix").[2]

2 The Liquidity Coverage Ratio

The LCR was introduced by the Basel Committee on Banking Supervision (BCBS) in December 2010 and revised in January 2013 as part of the Basel III Accord. The US version of LCR was first proposed in October 2013 and finalized in September 2014.[3] For bank j, LCR is equal to its unencumbered[4] HQLA divided by its total expected net cash outflows ($ENCO30$) over a prospective 30 calendar day period in a stress event:

$$LCR_j = \frac{HQLA_j}{ENCO30_j}. \tag{1}$$

[2] https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr852_appendix.

[3] The Basel and US versions of LCR have some differences (Bouwman (2018)).

[4] An asset is "unencumbered" if it is free of legal, regulatory, contractual, or other restrictions on the bank's ability to liquidate, sell, transfer, or assign it.

BHCs that hold at least \$250 billion in consolidated assets or are internationally active (i.e., with at least \$10 billion in on-balance-sheet foreign exposure) are required to have LCR $\geq$1 on a daily basis. We call them "*full-banks.*" If a full-bank's LCR falls below one on any business day, it must notify its supervising agency. After three consecutive shortfall days, it must submit a "plan for remediation" with a timeline for compliance. BHCs with consolidated assets of at least \$50 billion but less than \$250 billion – denoted "*mod-banks*" – are subject to a modified version of LCR that instead requires HQLA to meet outflows over 21 out of 30 calendar days. BHCs with consolidated assets under \$50 billion are not subject to the LCR.[5] These prudential size limits were changed after 2017, when our sample ends.

HQLA are classified into three categories by liquidity: Level 1, Level 2A, and Level 2B. Level 1 assets, the most liquid category, are not subject to a haircut and must constitute at least 60 percent of HQLA. Levels 2A and 2B assets are subject to 15% and 50% haircuts, respectively. The sum of Level 2A and 2B assets cannot exceed 40%, and Level 2B assets cannot independently exceed 15%, of the HQLA portfolio. The LCR rule specifies the eligible assets for each HQLA level (Panel A in Table A.1 of the appendix).

$ENCO30$ is the total expected cash outflows minus inflows maturing in 30 calendar days or less, estimated by applying outflow and inflow rates to outstanding liability balances and receivables, respectively.[6] However, inflows cannot offset more than 75% of outflows:

$$\begin{aligned} ACO30_j &= \sum_{k=1}^{k=n_l} O_{k,j} * L_{k,j} \\ ENCO30_j &= ACO30_j - Min(0.75 * ACO30_j, \sum_{m=1}^{m=n_a} I_{m,j} * A_{m,j}) \end{aligned} \tag{2}$$

$ACO30_j$ is the aggregate cash outflow in a 30 day period, and $L_{k,j}$ and $A_{m,j}$ are the liability and asset balances outstanding, respectively. $O_{k,j}$ and $I_{m,j}$ are the outflow and inflow rates that reflect historical stress events and depend on many factors. Liabilities that are volatile,

[5] Depository institutions that are subsidiaries of covered BHCs and have at least \$10 billion in consolidated assets are also subject to LCR.

[6] For balance sheet items without a contractual maturity, there is a maturity mismatch add-on.

uninsured, collaterized with illiquid assets or have institutional counterparties, tend to have high net outflow rates. For example, unsecured retail funding have outflow rates between 3% and 40% versus 5-100% for wholesale funding, depending on the account type (Panel B of Table A.1 in the appendix). Fully insured retail deposits are assigned outflow rates of 3 percent versus 10 percent for all other retail deposits. Outflow rates for repo transactions are 0-15% using Level 1 or 2A assets as collateral, but 25-100% with lower quality collateral.

The LCR rules are more stringent for full-banks than for mod-banks. In addition to facing higher HQLA requirements, full-banks were required to achieve 80% of LCR by 2015, 90% by 2016, and 100% by 2017. They had to calculate LCR on the last business day of each month beginning in January 2015 and on every business day beginning in July 2016. Full-banks were required to publicly disclose their LCR from April 1 2018. Mod-banks, by comparison, were required to achieve 90% of LCR by 2016 and 100% of LCR by 2017, calculate LCR only on a monthly basis and begin public disclosure by October 1, 2018.

3 Literature Review and Hypotheses Development

We review the literature on liquidity regulations (section 3.1) and then develop testable hypotheses to take to the data (section 3.2).

3.1 Literature Review

As private banking choices generate run externalities via asset- and liability-side distortions, regulations need to consider both sides of bank balance sheets, like the LCR does (Cecchetti and Kashyap (2018), Carletti et al. (2020) and Kashyap et al. (2020)). Further, banks face trade-offs between managing asset- and liability-side risk in responding to regulations. For example, when banks hold more liquidity, their current portfolio values increase due to reduced fire-sale risk but at the cost of lower future returns (Diamond and Kashyap (2016) and Carletti et al. (2020)). An implication is that banks' asset-side adjustments to the LCR are likely to vary with their reliance on stable funding, consistent with our findings.

The heterogeneity of bank responses muddies the implications of liquidity regulations for lending, and this is reflected in the empirical literature. Studies of regulations similar to LCR find evidence of higher, lower or no lending effects. For example, Banerjee and Mio (2018) find that national liquidity rules in the UK have no effect on lending but negative effects on short-term wholesale funding and interbank borrowings. For the Netherlands, Ananou, Chronopoulos, Tarazi and Wilson (2021) report that Dutch banks increase lending relative to unregulated banks while Haan and van den End (2013) find that most banks hold more liquid assets than required. Curfman and Kandrac (2022) study cash reserve requirements in the US and find that it causes banks to lend less. Naceur, Marton and Roulet (2018) study liquidity indicators while Chen, Goldstein, Huang and Vashishtha (2021) examine liquidity mismatches of banks and show that lending *increases* with more liquidity.

Studies of the effect of LCR on lending are less common but also produce mixed results. OFR (2014) suggest that lending decreases after an early version of LCR, but EBA (2013) find no effects on European banks. Sundaresan and Xiao (2021) compare *within* US LCR banks and find that LCR banks with a higher liquidity gap (i.e. between the mandated and actual liquidity ratios) in 2012Q4 lend less afterwards. While we mostly use difference-in-differences (DiD) regressions, we also show results based on treatment heterogeneity in section 5.6 but using an alternative approach since estimating the regulatory liquidity ratio accurately from Y-9C and Call Reports is challenging (Cetina and Gleason (2015)). A more detailed comparison of the two approaches is provided in section 5.6. Notably, unlike us, these papers do not consider the benefits from LCR nor quantify its net benefits.

Theoretical studies mostly derive a negative effect of liquidity regulations on lending. Perotti and Suarez (2011) conclude that liquidity regulations limit credit expansion when banks differ in their incentives to take on risk. Kashyap et al. (2020) argue that planners need to balance the benefits of greater liquidity provision against the costs of lower credit extension when correcting run risk. They recommend a lending subsidy to supplement LCR as banks will otherwise channel less deposits towards loans. Calibrations of macro-finance or general equilibrium models also find a negative effect on lending (De Nicolo, Gamba and Lucchetta (2014), Heuvel (2017)) but not on deposits (Covas and Driscoll (2015)). Our findings imply that covered US banks adjust to LCR mainly on the asset side in cutting their relative loan shares, different from the responses of European banks (EBA (2013)).

While the sources of run risk differ across models, we are motivated by those that focus on fire-sale externalities. Mostly, they suggest that fire-sale risk is lower after liquidity regulations (for example, Bolton, Cecchetti, Danthine and Vives (2019), Kara and Ozsoy (2020) and Carletti et al. (2020)), although it may increase if the resulting bank exposures are correlated (Cecchetti and Kashyap (2018)) or if the money premium is higher (Hanson, Shleifer, Stein and Vishny (2015)).[7] Our result that the largest banks reduce their fire-sale externalities is supportive of the former hypothesis.

Our analysis of LCR and liquidity creation relates to Berger and Bouwman (2009) who show a positive relation between capital and liquidity creation by large banks, and to Berger, Bouwman, Kick and Schaeck (2016) who find no effect of capital support on liquidity creation.

If actual regulations do not align with the theoretically optimal design, there may be unintended consequences. For example, inefficiencies may arise as the same liquidity ratio applies to all banks, even though it is generally optimal for liquidity requirements to vary with bank characteristics (Farhi, Golosov and Tsyvinski (2009), Diamond and Kashyap (2016) and Carletti et al. (2020)). Nevertheless, as our results suggest, the *effects* of liquidity regulations are heterogeneous due to the endogeneity of bank responses. Further, while Dewatripont and Tirole (2018) provide theoretical support for a liquidity-weighted approach, unintended consequences may occur when choosing these weights (Glaeser and Shleifer (2001)). Consistent with this notion, we find that as the LCR favors GNMA over GSE MBS, covered banks increase their relative holdings of the former, even though there

[7] In equilibrium, banks must be indifferent between a strategy with high fire-sale discount and one with high money premium. Because the money premium arises from deposit insurance and capital requirement costs, it may increase if the LCR encourages banks to hold more long-term loans to maturity and fund these loans with insured deposits (Diamond and Kashyap (2016)).

were no changes in risk weights of GNMA or GSE MBS from capital rules. Gete and Reher (2020) show that this shift has unintended consequences for the mortgage market. In Europe, Schmidt (2019) shows that banks arbitrage differences in relative liquidity weights of assets in LCR and the ECB's collateral framework.

3.2 Hypotheses Development: Costs and Benefits of LCR

For a given asset size, LCR requires banks to increase their share of HQLA, or decrease their shares of short-term, volatile liabilities, or do both. If banks do not change their liabilities, they will need to cut non-HQLA assets (e.g., loans) to meet their LCR targets.

Hypothesis 1: Lending. Covered banks will reduce their total loan shares after LCR, relative to exempt banks.

The extent to which LCR banks cut loans likely depends on their mix of assets *and* liabilities prior to the finalization of LCR. Relatively low initial shares of HQLA imply that banks need to increase HQLA and cut lending more to comply with LCR. Conversely, if banks do not adjust assets, they will need to rely more on longer-maturity, stable funding. Thus, relatively low initial shares of stable funding give banks more scope to comply with LCR by increasing stable funding instead of cutting loans (especially since the cost of obtaining such funding was relatively low during our sample period).

Hypothesis 2: Treatment Heterogeneity. Covered banks with lower shares of liquid assets prior to LCR cut their lending shares more after LCR. Covered banks with lower shares of stable funding prior to LCR reduce their lending shares less after LCR.

Risk-based capital rules and stress tests may also affect lending (e.g., by reducing incentives to monitor borrowers or by increasing the capacity to absorb risk). While capital rules also apply to banks covered by the LCR, we exploit differences in their implementations to argue that our main results are not driven exclusively by any effects from capital regulations.

Hypothesis 3: Capital Regulations and LCR. If LCR constrains bank lending, then (a) loans to large and small firms will decrease by similar amounts; (b) banks not included in the stress tests of 2013 will reduce lending during 2013Q2-2014, (c) global systemically important banks (G-SIBs) and non-G-SIB full-banks will have similar lending reductions, and (d) asset holdings will respond to LCR haircuts even if regulatory risk-weights are unchanged.

Loans to smaller borrowers are expected to suffer larger reductions if capital rules are binding. While standardized risk-weights make no distinction between small and large borrowers, Covas (2017) finds that risk-weights implied by stress tests are higher for small business loans than for aggregate C&I loans and, further, stress-tested banks have reduced small business loans since 2011 compared to non-stress-tested banks. Acharya, Berger and Roman (2018) and Cortes, Demyanyk, Li, Loutskina and Strahan (2020) show that banks subject to the stress tests cut loans to small business borrowers. In contrast, the LCR rules make no distinction between loans based on borrower size and thus should impact large and small borrowers similarly.

Since 2009, large banks have been subject to stress tests requiring them to calculate their expected capital surplus under macroeconomic stress scenarios. As risky assets are more sensitive to business cycles, the stress tests imply their own risk-weights, complementing the standardized risk-weights (Covas (2017)). Some LCR banks (denoted *late stress test* (*LST*) banks) did *not* take part in the initial stress tests but did so from 2014 onward. Given evidence that stress test banks lend less in the year after stress tests (Acharya et al. (2018)), lower lending by *LST* banks in 2013Q2-2014 is likely attributable mainly to LCR.

Unlike the LCR, capital rules are more stringent for G-SIBs relative to other full-banks. Since 2014, G-SIBs have been subject to a capital surcharge and loss-absorbency requirements (Bouwman (2018)). The capital surcharge or stress tests are likely to result in less lending, as evidenced by Chen, Hanson and Stein (2017) who find that the four largest banks (all of who are G-SIBs) cut small business lending more than other banks. Thus, we expect larger changes in G-SIB lending relative to other full-banks if only capital rules are binding but similar lending reductions if LCR is also a binding constraint on bank balance sheets.

To study the effect of risk-weights relative to LCR haircuts, we compare GNMA and

GSE MBS – an asset pair of similar risk but with a lower LCR haircut for GNMA (i.e. zero since it is a Level 1 asset versus 15% for GSE which is a Level 2a asset). In contrast to LCR, risk-weights for GSE and GNMA MBS were unchanged during our sample (see risk weights). Thus, if LCR is the binding constraint, then we expect LCR banks to increase their holdings of GNMA but not of GSE. If risk-based capital rules are binding, then we should find no changes in either GNMA or GSE holdings post-LCR relative to the pre-LCR period.

Hypothesis 4: Bank Liquidity Creation. Relative to non-LCR banks, covered banks' asset-side liquidity creation decreases after LCR.

Lower lending shares likely result in lower asset-side liquidity creation given the large share of loans in total assets. The effect on LCR banks' liability-side liquidity creation is ambiguous since LCR outflow rates depend on counterparty, collateral and term. For example, banks have an incentive to both reduce short-term wholesale funding and to increase stable retail deposits in response to LCR, creating offsetting effects on liquidity creation.

Hypothesis 5: Fire-Sale Risk. Relative to non-LCR banks, the fire-sale externality of covered banks is lower after LCR.

Fire-sale risk of LCR banks is expected to be lower after LCR if lower shares of illiquid assets lead to a lower concentration of such assets among them. But, the price impact of fire-sales will *increase* if LCR induces banks to hold similar, correlated exposures or if the money premium is higher. The hypothesis is that the former effect outweighs the latter, resulting in reduced fire-sale risk.

4 Data and Methodology

We describe the data in section 4.1. Our empirical methodology is described in section 4.2. The validity of the parallel trends assumption is examined in section 4.3.

4.1 Data

Bank balance sheet items are from the FR Y-9C report except for small business lending and insured deposits that are from Call Reports, as these data are not reported on the Y-9C. We also distinguish between different types of deposits — insured and uninsured deposits, and core deposits, as further discussed in Section B.1 of the appendix.

We construct a balanced panel of US banks from 2009Q1 until 2017Q4. The sample start date is chosen to remove effects due to the Global Financial Crisis (GFC), while the end date precedes regulatory changes in May 24, 2018 after which smaller mod-banks became exempt from LCR. Section B.2. of the appendix provides further details of our panel construction.

We define non-LCR banks as midsized banks with assets between \$3 billion and \$50 billion. Smaller banks are excluded as they are typically community banks with unique characteristics. Panel A of Table 1 presents summary statistics for the 109 banks in our sample. The sample includes 12 full-banks, 13 mod-banks and 84 non-LCR banks for a total of 3,924 bank-quarters. As data on control variables are missing for eight bank-quarters, the regressions use 3,916 observations. The average assets of full, mod and midsized banks in the pre-LCR period (2009 to 2013Q1) are \$894 billion, \$99 billion and \$10 billion, respectively, and they each increase over the sample period.

We also examine bank-level changes in standards and terms of C&I loans as reported in SLOOS.[8] For loans to large or small firms, the survey asks banks whether standards or terms over the past three months have tightened, eased or stayed the same. For standards and terms separately, we code these responses as -1 (looser), 0 (same) or 1 (tighter). We then combine them to define $StanTerm$ – an indicator for tightening, easing or not changing standards or terms (see Section B.3 of the appendix for details). There are 80 domestic banks in the survey with meaningful C&I loan activity, covering all 12 Fed districts. After merging with the Y-9C data and rebalancing the panel, we have 1,006 observations for small

[8]While the aggregated SLOOS survey results are made public, the micro-SLOOS data that we use is not. See `https://www.federalreserve.gov/data/sloos/about.htm` for further details.

firms and 1,078 for large firms. All LCR banks are included while the non-LCR banks are on average larger than those in our full sample, implying a closer size-match between the treatment and control groups in the SLOOS sample.

Since 2010Q3, the SLOOS survey asks banks to give the reason for changing standards or terms, with one response being "increased concerns about the effects of legislative changes, supervisory actions, or changes in accounting standards." Since no major changes in accounting standards occur for large banks during this period, the responses likely reflect regulatory or supervisory concerns only.[9] We define the variable *RegTight* to indicate whether banks tighten standards or terms for regulatory or other reasons (see Section B.3 of the appendix).

4.2 Methodology

We estimate DiD panel regressions for bank i and quarter t:

$$\frac{\Delta Y_{it}}{A_{i,t-1}} = \alpha_0 + \alpha_i + \alpha_t + \delta_1 \textit{Post-LCR}_t \times \textit{LCR-Bank}_i + \sum_{j=1}^{4} \beta_{ij} \frac{X_{ijt-1}}{A_{i,t-1}} + \epsilon_{it} \tag{3}$$

where Y is the outcome variable (i.e., loans, liquidity creation or illiquidity risk) and A is total assets.[10] The vector X includes bank controls, as described below. Y and X are normalized by the previous period's assets to account for bank size effects. *Post-LCR* is 1 from 2013Q2 to 2017Q4 and 0 otherwise. *LCR-Bank* = 1 for banks with assets of \$50 billion or more. Non-LCR banks are the omitted group. Standard errors are clustered by bank and robust to heteroskedasticity and serial correlation. The coefficient of interest is δ_1, which indicates the change in outcome for LCR banks relative to non-LCR banks from the pre- to the post-LCR period.

We use bank fixed effects α_i to account for bank characteristics that may be correlated

[9] Many accounting standard updates are clarifications of existing laws and not amendments or do not apply to large banks (see Accounting standards). As updated standards do not become effective for a few years, we look for amendments that apply to large banks between 2009-2013: No. 2009-06, 2011-03, 2011-08 and 2012-02. All relate to intangibles and transfers and servicing, and likely irrelevant to lending decisions.

[10] We use the change, rather than the level of Y, due to the high serial correlation in levels of Y. Alternatively, one might estimate a DiD regression in levels and include lags of Y but, as discussed in Angrist and Pischke (2009), consistent estimates of the treatment effects are difficult to obtain in these models.

with LCR shocks. To further evaluate these effects, we test for parallel pre-trends (section 4.3), and run "placebo" tests with alternative bank size groupings (section 5.4) and event dates (section 5.5). The period fixed effects α_t control for bank-independent credit demand effects (e.g., from changes in the macro-economy). Examining lending standards in section 6 allow us to further distinguish credit demand and credit supply effects.

The bank controls X are the net interest margin, to indicate the profitability of lending; common equity tier 1 to risk-weighted assets ratio (CET1), to measure the effects of regulatory capital; non-performing loans as shares of total loans, which proxies for bank risk; and core deposits as shares of total assets, since access to core deposits may encourage riskier loans (Black, Hancock and Passmore (2010)).

Next, we separate LCR banks into full- and mod-banks. Since the former needed to be compliant with LCR earlier, we split the post-LCR period into *2013Q2-2014* and *2015-2017*. The coefficients of interest in (4) are δ_1 and δ_3 for full-banks and δ_2 and δ_4 for mod-banks.

$$\begin{aligned}\frac{\Delta Y_{it}}{A_{i,t-1}} &= \alpha_0 + \alpha_i + \alpha_t + \delta_1 \mathit{2013Q2\text{-}2014}_t \times \mathit{Full\text{-}Bank}_i + \delta_2 \mathit{2013Q2\text{-}2014}_t \times \mathit{Mod\text{-}Bank}_i \\ &+ \delta_3 \mathit{2015\text{-}2017}_t \times \mathit{Full\text{-}Bank}_i + \delta_4 \mathit{2015\text{-}2017}_t \times \mathit{Mod\text{-}Bank}_i + \sum_{j=1}^{4} \beta_{it} \frac{X_{it}}{A_{i,t-1}} + \epsilon_{it}\end{aligned} \tag{4}$$

A departure from these specifications occurs in Table 5, where we conduct a placebo test by using bank size buckets of \$40 billion width instead of the full- and mod-bank groups.[11]

4.3 Parallel trends assumption

We test for parallel pre-trends by estimating DiD coefficients in every period except 2013Q1:

$$\frac{\Delta Y_{it}}{A_{i,t-1}} = \alpha_0 + \alpha_i + \alpha_t + \sum_{t \neq k} \delta_t \mathit{Full\text{-}Bank}_i I(t) + \sum_{t \neq k} \gamma_t \mathit{Mod\text{-}Bank}_i I(t) + \sum_{j=1}^{4} \beta_{ij} \frac{X_{it}}{A_{i,t-1}} + \epsilon_{it} \tag{5}$$

[11]Since some banks move between these smaller buckets, the size bucket dummy variables are no longer absorbed by the bank fixed effects. So we include them in the regressions (although their estimates are not shown for brevity). Removing these transitioning banks was infeasible due to sample size considerations. In other tables of this paper, we use bank groups that are fixed over time, and so this issue does not arise.

I is an indicator variable equal to 1 for all quarters except k=2013Q1, the last quarter of the pre-LCR period. We require that δ_t and γ_t are not significantly different from zero for $q < t$ (i.e. the pre-LCR period). In Section B.4 of the appendix, we plot δ_t and γ_t for periods $t < k$ and $t > k$ and the associated confidence intervals, for our main outcome variables (i.e., lending, liquidity creation and the illiquidity component of fire-sale risk). Consistent with parallel pre-trends, we find that, for $t < k$, the confidence bands straddle zero in virtually all quarters for all outcome variables. Further, the outcome variables shift down in the post-event period, with δ_t and γ_t mostly below the zero line since 2013Q2. However, the quarter by quarter estimates are often insignificant, suggesting the tests have low power.

Accordingly, we provide additional tests suggested in the literature (reported in section B.4 of the appendix) to support parallel pre-trends and rule out alternative hypotheses. First, we include differential pre-trends in the regressions and show that differences in the slopes for LCR and midsized banks are insignificantly different from zero. Further, we show that the post-event trend is significantly more negative for LCR banks. These results are consistent with parallel pre-trends and rule out the alternative hypothesis that post-LCR outcomes are continuations of a pre-event trend. The sensitivity of our results with respect to alternative event dates is discussed in section 5.5.

5 Bank Adjustments to LCR

In this section, we evaluate the effects of LCR on bank balance sheets. Section 5.1 provides an overview of bank asset- and liability-side changes after LCR. To test Hypothesis 1, we examine changes in lending by LCR banks relative to non-LCR banks since 2013Q2 (section 5.2). In section 5.3, we provide several tests to distinguish between the effects of liquidity and other regulations implemented during our sample, including those outlined in Hypothesis 3. We check the robustness of identifying LCR effects with asset size cutoffs by considering "placebo" bank size groupings (section 5.4). We also check robustness with respect to alternative event dates and omitting the event quarter (section 5.5). Finally, we examine treatment heterogeneity (Hypothesis 2) – whether LCR banks' pre-LCR liquid asset and runnable liabilities shares affect their post-LCR lending shares (section 5.6).

5.1 Changes in Bank Balance Sheets Following LCR

Table 1 provides descriptive statistics of bank assets and liabilities around LCR. Panel A of the table shows that, as a share of total assets, HQLA increases for LCR banks – especially for the most liquid Level 1 assets – and decreases for non-LCR banks from the pre- to the post-LCR period.[12] The share of structured products – close to 9% of assets for full-banks pre-LCR – decreases for all banks after LCR.[13] Loans are the dominant share of assets, ranging from 42% to 68%. LCR banks' loan shares decrease only slightly post-LCR but that of midsized non-LCR banks increases (also see Figure 1). The lower *relative* loan share of LCR banks suggests an opportunity cost of foregone lending that we quantify in section 8.2.

Panel B of Table 1 reports descriptive statistics of liabilities. LCR penalty rates are relatively high for short-term funding and relatively low for stable retail and insured deposits (see section 2). Both full- and mod-banks decrease their shares of overnight (ON) repo and fed funds (columns 1 and 2). Panel B of Table C.1 in the appendix reports that, relative to midsized banks, the changes are significant for ON repo holdings of full-banks in 2013Q2-2014 and for ON fed funds holdings for all LCR banks in 2015-2017.[14] Insured deposit shares increase for full-banks while core deposit shares increase for all LCR banks (columns 3 and 4). However, relative to midsized banks, stable funding shares decrease for LCR banks although the changes are mostly not significant (Panel B of Table C.1 in the appendix).

[12] Our HQLA calculations incorporate LCR haircuts and caps (to the extent they are binding). Since we do not have data on excess reserves, we approximate it by the sum of cash and reserve balances minus estimated reserve requirements.

[13] Relative to non-LCR banks, changes in HQLA and Level 1 assets are significant for LCR banks while changes in structured products are significant for full-banks (Panel A of Table C.1 in the appendix).

[14] Roberts, Sarkar and Shachar (2018) show a shift to repo and fed funds funding of maturity exceeding one-year by covered banks after LCR. Macchiavelli and Pettit (2021) show that dealers reduce their reliance on repos to finance inventories of HQLA. This is because, while LCR outflow rates for repos are low when the collateral is a level 1 or level 2A asset, these assets then become "encumbered" and ineligible as HQLA.

Overall, covered banks increase their share of HQLA and decrease their shares of less liquid assets following LCR. While their loan share falls only slightly, LCR banks lose market share to midsized banks. On the liability-side, the effects of LCR are less clear, consistent with the discussion in section 3.2. While LCR banks shift to term funding, their shares of stable funding do not appear to increase relative to midsized banks.

5.2 Effect of LCR on Bank Lending

Panel A of Table C.2 in the appendix reports descriptive statistics for our control variables. On average, for all banks, the share of nonperforming loans and the net interest margin decrease in the post-LCR periods, suggesting that both the profitability and the risk of lending fall. The average Tier 1 capital ratio increases for LCR banks and decreases for midsized banks during this period. While lower profitability discourages lending, lower risk and higher capital likely do the opposite, and so the overall effect on lending is ambivalent.

Table 2 reports results for changes in loans as shares of lagged assets for LCR relative to non-LCR banks. We find that LCR banks lend 1.30% less between 2013Q2 and 2014 and 1.48% less in 2015-2017, relative to midsized banks (column 1). Of the control variables, higher capital ratios and lower shares of nonperforming loans increase lending significantly. Net interest margins and core deposit shares have insignificant effects on total loans. Reduced securitizations may also lower lending capacity (Maddaloni and Peydró (2011)), but we show in Table C.3 of the appendix that changes in securitization are not driving these results.[15] The significant negative effect of LCR on lending is consistent with US banks having adjusted to the regulations mainly by shedding illiquid assets, per Hypothesis 1.

Column 2 of the table shows that both mod- and full-banks reduce lending significantly in 2013Q2-2014 and 2015-2017. Thus, even though mod-banks did not implement LCR till 2016, it appears that they adjusted their asset mix ahead of the regulations. Indeed, Ihrig,

[15] In particular, the coefficient on a lagged securitization dummy is generally positive, as hypothesized, but insignificant. The dummy is 1 if the securitization income is positive and 0 otherwise. We use a dummy variable as many banks have zero securitization income in several quarters.

Kim, Kumbhat, Vojtech and Weinbach (2017) report that some banks publicly discussed LCR in their quarterly earnings calls as early as 2014. Nevertheless, we find that, while full-banks reduced lending significantly in 2013, mod-banks did not do so till 2014 (see Table C.4 in the appendix). Moreover, the reductions in total lending are larger for full-banks than for mod-banks, based on a Wald test. Hence, the results are consistent with mod-banks facing less stringent restrictions than full-banks.

5.3 Effects of Other Regulations on Bank Lending

In addition to LCR, many other regulations were implemented during our sample and thus, the estimated effect on lending is likely a composite of several regulations.[16] We now examine whether these non-LCR regulations could *entirely* account for the estimated lending effects.

5.3.1 Stress tests

Following Hypothesis 3(a), stress-testing constraints predict a larger reduction in lending to small firms whereas LCR constraints predict similar reductions to large and small borrowers. Panel B of Table C.2 in the appendix and Figure 1 show that the share of small business C&I loans declines for all bank groups since 2009, even as their overall C&I loan shares increase. Columns 3 and 4 of Table 2 show no evidence of *significantly more* negative effects for C&I loans to small firms than to all firms, inconsistent with the effects of capital constraints. In all cases, relative to midsized banks, LCR banks reduce their total C&I loan shares more than their small business C&I loan shares, although in two cases (for mod-banks in 2013Q2-2014 and full-banks in 2015-2017) the reductions in small business loans are significant while those in total C&I loans are insignificant.

To further distinguish the effects of stress tests and LCR, we isolate those LCR banks not included in the stress tests prior to 2014, denoted *LST* banks (see Hypothesis 3(b)). The

[16] Large banks also incurred substantial legal settlements following the global financial crisis (GFC). However, these were exclusively paid by the largest banks (see violations tracker). As discussed below, we do not find the largest lending effects for the biggest banks.

remaining LCR banks are denoted *early stress test* or *EST* banks. These banks are listed in Table C.5 in the appendix. Since the hypothesis relates only to 2013Q2-2014, the sample for these regressions ends in 2014. Column 1 of Table 3 shows that *LST* banks reduce total loans by 0.95% while *EST* banks cut lending by 1.55% in 2013Q2-2014, relative to non-LCR banks. A Wald test shows that we cannot reject the equality of these coefficients. Similar results obtain for all and small business C&I loans (columns 2-3), as *LST* banks reduce lending by statistically similar amounts as *EST* banks in 2013Q2-2014. The results are consistent with banks shedding loans due to LCR, over and above any stress test effects.

Could the results for *LST* banks be due to anticipation effects of stress tests? The Fed announced the rules governing the 2014 stress tests on October 12, 2012 (see DFAST2012). The bottom panels of Figure B.1 in the appendix shows that *LST* banks do not significantly cut lending relative to midsized banks in 2012Q4 – prior to LCR but after the announcement of the 2014 stress tests – inconsistent with an announcement effect.

Banks that fail the stress tests are subject to restrictions on their dividends and share buybacks. Since there may be significant lending effects of stress test failures, we exclude from our sample banks that failed the tests in various years and obtain similar results (see Table C.6 in the appendix).

5.3.2 Risk-based capital rules

Per Hypothesis 3(c), G-SIBs face additional capital requirements compared to non-G-SIB full-banks (such as a capital surcharge) while LCR treats both groups similarly. We separate G-SIBs from other full-banks in columns 5-7 of Table 2. For G-SIBs relative to non-G-SIB full-banks, changes in total (C&I) loans are lower (higher) while changes in small business loans are similar in 2013Q2-2014 and higher in 2015-2017. However, in all cases, changes in loans are not statistically different for G-SIBs compared to those of other full-banks, according to the Wald tests. For other loan types (i.e., real estate, credit card and consumer loans), changes in shares for G-SIBs are either smaller than or similar to those for other full-banks, inconsistent with the effects of enhanced capital rules (see Table C.7 in the appendix). One exception is consumer loans, where we observe a greater reduction for G-SIBs than for non-GSIB full banks, but these differences are not statistically different, based on Wald tests.

Following Hypothesis 3(d), we compare the effect of risk-weights and LCR haircuts on bank behavior by estimating changes in the GNMA MBS and GSE MBS holdings of LCR banks. Table 4 reports the results. We find that GNMA MBS holding, as shares of lagged assets, increase significantly relative to midsized banks for LCR banks (column 1), with this increase mostly attributable to mod-banks (column 2). By comparison, the GSE MBS holdings betray no LCR effects (columns 3-4). These results indicate that banks increase their holdings of the asset with the lower LCR haircut, relative to another asset with similar risk but higher LCR haircut. Since regulatory risk-weights on the asset pair were constant during our sample, these results are unlikely to reflect effects of risk-based capital rules.

5.3.3 Leverage ratio

In 2012, US regulators proposed the supplementary leverage ratio (SLR) that require full-banks to maintain a minimum ratio of 3% of tier 1 capital to total on- and off-balance sheet exposures. Since the leverage ratio treats all exposures equally, it creates incentives for banks to *increase* their shares of risky assets (Choi, Holcomb and Morgan (2020)), contrary to the evidence presented in this paper. But Covas (2017) finds that the SLR becomes risk-sensitive in the post-stress scenario since banks with larger balance sheets are more sensitive to business cycles. If so, G-SIBs may reduce lending relative to non-G-SIB full-banks as they have been subject to a higher leverage ratio (the eSLR) since 2014, but we have shown that this is typically not the case.

5.3.4 CLAR and enhanced supervision

The Fed uses the Comprehensive Liquidity Analysis and Review (CLAR), introduced in 2012, for institutions subject to the Large Institution Supervision Coordinating Committee

(LISCC) program to assess more accurately bank-specific liquidity risk during a crisis. It includes a bank-run liquidity stress test, an independent Federal Reserve review of the bank's analysis, and an evaluation of the banks' liquidity planning and governance (see LISCC). Enhanced supervision require higher standards for internal risk controls and is disproportionately focused on the largest 5 banks (Hirtle, Kovner and Plosser (2020)). Thus, both CLAR and enhanced supervision affect the largest and most systemically important banks. However, we do not find that the LCR effects are greatest for the largest banks, as further examined in section 5.4 below. Moreover, we omit from our sample the LISCC banks that CLAR was applied to and find our results little changed (see Table C.8 in the appendix).

5.3.5 Discussion

Given the sheer volume of non-LCR regulations implemented during our sample period, some of our estimated lending effects may well be due to these other regulations. Nevertheless, the evidence presented in this section suggests that non-LCR regulations are unlikely to entirely account for our estimated lending effects. In particular, we have shown that lending reductions by LCR banks mostly occur independent of participation in stress tests, borrower size and G-SIB designations. Moreover, asset holdings of LCR banks respond to LCR haircuts even when there are no changes in the risk weights. Finally, evidence based on differences in the incidence of LCR and non-LCR regulations on banks of various sizes are consistent with incremental LCR effects – an issue that is further discussed in the next section.

5.4 Bank Size or LCR Effects? Additional Investigations

As large banks have different business models than smaller banks and are more heavily regulated, our results may be driven by bank size rather than LCR (EBA (2013)). Our prior results show that the decline in the non-G-SIB full banks' lending is similar to that of the G-SIBs (that have unique business models). Also, the presence of parallel pre-trends and the inclusion of bank fixed effects mitigate the concern about bank size to some extent.

Nevertheless, we perform a placebo test to separate the effects of bank size and the LCR threshold of $50 billion. Specifically, we use dummy variables for each $40 billion size bucket starting from $10 billion up to $250 billion. In addition, banks with size $\geq$ $250 billion are separated into G-SIBs and non-GSIBs.[17]

The results for total loans are reported in column 1 of Table 5; the remaining columns are discussed in sections 7 and 8. Changes in total lending of banks in the $10 – $50 billion group – who are subject to certain capital rules but not LCR[18] – are not statistically significant. In contrast, the lending share of the $50 – $90 billion group declines by 1.10% and the change is significant at the 1% level. Since both groups face capital regulations but LCR only applies to the larger group and, moreover, these groups are similar in size, this additional decline in lending is likely an effect of the LCR. Further, banks with assets $\geq$ $250 billion do not cut loan shares the most, even though they face the strictest capital regulations. Finally, G-SIBs do not reduce lending more than non-G-SIBs. Thus, bank groupings using LCR cutoffs are not just proxies for size- or business model-based differences, but rather identify LCR effects in addition to those from capital rules.

5.5 Alternative Event Dates and Event Quarter Effects

Could US banks have started adjusting to the LCR earlier than 2013Q1 (our event date)? While some banks started to calculate internal metrics of LCR as early as December 31 2012, actual compliance could not occur till 2013 due to uncertainty about the final version of the LCR (see, for example, JPMC (2013)). Consistently, the dynamic DiD coefficients for total loans (see Figure B.1 in the appendix) are mostly on or above the zero line prior to 2013Q2. To further examine this issue, for the pre-treatment sample of 2009-2012, we estimate a DiD regression with an alternative event date of 2011Q1 and find no significant changes in lending since 2011Q2, relative to midsized banks (see Table B.2 in the appendix).

[17] In similar vein, Bindal, Bouwman, Hu and Johnson (2018) identify the effects of the Dodd-Frank Act (DFA) by examining banks within size bands 30% above and below the size thresholds of $10 and $50 billions.

[18] Basel III rules increased the amount and quality of capital that *both* LCR and non-LCR banks must hold against risk-weighted assets (Walter (2019)).

Could the event date be later, given that the US rules were not finalized until 2013Q4 (and eligibility of municipal bonds for HQLA was not decided until 2018)? Since full-banks shed loans significantly in 2013Q2-2013Q4 (see Table C.4 in the appendix), it appears that at least the largest LCR banks adjusted after the finalization of the Basel version of LCR.

To account for potential contaminating effects from announcements, we exclude the event quarter of 2013Q1 and obtain virtually unchanged results (see Table C.9 in the appendix).

5.6 Pre-LCR Heterogeneity and Bank Lending

In this section, we examine Hypothesis 2 which states that covered banks with *lower* shares of stable funding and *higher* shares of HQLA and Level 1 assets prior to LCR, cut lending less after LCR. We choose 2011Q1 as the pre-regulation baseline.[19]

For the sample of 25 LCR banks, we regress changes in total loans on *Post-LCR* interacted with 2011Q1 shares of stable funding and liquid assets.

$$\frac{\Delta Y_{it}}{A_{i,t-1}} = \alpha_0 + \alpha_i + \alpha_t + \delta_1 Post\text{-}LCR_t \times \frac{Z_{i,2011Q1}}{A_{i,2011Q1}} + \sum_{j=1}^{4} \beta_{ij} \frac{X_{ijt-1}}{A_{i,t-1}} + \epsilon_{it} \tag{6}$$

where $Y = Total\,Loans$ and $Z_{2011Q1} = Conditioning\,Variable$ in 2011Q1. Results are in Panel A of Table 6, with columns 1-4 and columns 5-8 showing results when conditioning on stable funding shares and liquid asset shares, respectively, in 2011Q1. We find that pre-LCR shares of stable funding and liquid assets are not significantly related to loan growth. One exception is core deposits which is weakly related to loan growth (column 4).

Pre-LCR balance sheet constraints may be different for mod- and full-banks. On the one

[19] Sundaresan and Xiao (2021) also estimate treatment heterogeneity using the gap between required and actual liquidity ratios in 2012Q4 as their pre-LCR variable. There are four differences with our approach. First, we use balance sheet values rather than the liquidity ratio. While the ratio is meant to proxy LCR, the latter cannot be accurately estimated from Call Reports and Y-9C. Cetina and Gleason (2015) document the complexity of LCR calculations (e.g., it requires over 300 inputs, HQLA diversification and various cash flow adjustments to the denominator). Second, we perform separate analyses for asset and liability items since they have opposite implications for loan growth whereas the liquidity ratio combines assets and liabilities. Third, we use 2011Q1 as the pre-LCR benchmark because anticipatory effects of the LCR may already be reflected in banks' portfolios in 2012Q4 (EBA (2013)). Fourth, we separate the effects for full- and mod-banks that have different pre-LCR balance sheet constraints.

hand, as full-banks were required to meet higher LCR ratios along with earlier compliance (section 2), they may be more sensitive to pre-LCR constraints. On the other hand, the pre-LCR shares of HQLA and Level 1 assets were already high for full-banks relative to that of mod-banks (Table 1), implying reduced sensitivity to initial shares. Further, balance sheet constraints at a point in time may become less binding in later periods. Accordingly, we modify (6) to identify incremental effects for full-banks and in 2015-2017, as follows:

$$\begin{aligned}\frac{\Delta Y_{it}}{A_{i,t-1}} &= \alpha_0 + \alpha_i + \alpha_t + \delta_1 \mathit{2013Q2\text{-}2014}_t \times \frac{Z_{i,2011Q1}}{A_{i,2011Q1}} + \delta_2 \mathit{2015\text{-}2017}_t \times \frac{Z_{i,2011Q1}}{A_{i,2011Q1}} \\ &\quad + \gamma_1 \mathit{Full\text{-}Bank}_i \times \mathit{2013Q2\text{-}2014}_t \times \frac{Z_{i,2011Q1}}{A_{i,2011Q1}} + \gamma_2 \mathit{Full\text{-}Bank}_i \times \mathit{2015\text{-}2017}_t \times \frac{Z_{i,2011Q1}}{A_{i,2011Q1}} \\ &\quad + \gamma_3 \mathit{Full\text{-}Bank}_i \times \mathit{2013Q2\text{-}2014}_t + \gamma_4 \mathit{Full\text{-}Bank}_i \times \mathit{2015\text{-}2017}_t + \sum_{j=1}^{4} \beta_{ij} \frac{X_{ijt-1}}{A_{i,t-1}} + \epsilon_{it}\end{aligned} \tag{7}$$

The results are reported in Panel B of Table 6. Column 2 (Z=ON repo) of the table shows that $\gamma_1 > 0$ and statistically significant. Since $(\delta_1 + \gamma_1) > 0$, this implies that full-banks with higher pre-LCR shares of ON repo (i.e., lower stable funding shares) have significantly higher loan growth in 2013Q2-2014, as hypothesized. Moreover, column 3 (Z=Insured deposits) reports that γ_1 and γ_2 are both negative and statistically significant, indicating that lower pre-LCR shares of insured deposits for full-banks predict higher loan growth in 2013Q2-2014 and also in 2015-2017 (since $(\delta_2 + \gamma_2) < 0$). Finally, column 6 ($Z$=Level 1 assets) reports that $\gamma_2 > 0$ and significant, indicating that higher pre-LCR shares of Level 1 assets of full-banks predict higher loan growth in 2015-2017, also as hypothesized. Thus, lower pre-LCR stable funding shares and higher pre-LCR liquid asset shares appear to mitigate post-LCR lending reductions by full-banks, suggesting that these banks take into account potential synergies between their assets and liabilities when responding to LCR.[20]

[20] However, in contrast to full-banks, lower pre-LCR stable funding shares of mod-banks reinforce rather than mitigate post-LCR lending reductions, perhaps suggesting different pre-LCR balance sheet constraints for full- and mod-banks. Specifically, for mod-banks, $\delta_1 < 0$ and significant when $Z = \mathit{ON\ repo}$ and $\delta_2 > 0$ and significant when $Z = \mathit{Insured\ deposits}$.

6 Bank Lending Standards and Terms

While changes in loan amounts reflect both credit demand and supply conditions, changes in lending standards and terms should mostly reflect supply side conditions. In this section, we examine bank-level changes in standards and terms of C&I loans as reported on SLOOS. We also examine to what extent banks' changes in standards or terms are related to regulations.

The blue-shaded bars in Figure 2 plot the share of banks that change standards or terms for small firms (top panel) and large firms (bottom panel). Increased tightening (easing) is indicated by bars above (below) the zero line. While there are more instances of easing than tightening, more LCR banks appear to tighten standards or terms for small and large borrowers compared to midsized banks.

In Table 7, we report results from panel regressions using $StanTerm$ as the dependent variable. $StanTerm$ equals 1 (-1) if both standards and terms are tighter (looser) or if one is tighter (looser) and the other is "no change," while it is 0 if both standards and terms are unchanged. In case of conflicting answers (e.g., standards tighter but terms easier), $StanTerm$ is coded as missing (see section B.3 of the appendix).[21] A positive coefficient indicates that LCR banks tighten standards or terms more often after LCR than before LCR, relative to non-LCR banks. We find that LCR banks significantly tighten standards or terms for large firms in 2013Q2-2014 and 2015-2017 (column 1). Column 2 shows that mod-banks tighten standards or terms for large firms but results for full-banks are not significant. To purge effects unrelated to credit supply, Bassett, Chosak, Driscoll and Zakrajsek (2014) regress standards on macro and financial conditions, risk tolerance and other SLOOS responses regarding loan demand, and show that the regression residual is a good proxy of the supply of bank loans. We perform a similar regression for $StanTerm$[22] and use the regression residual as the outcome variable, and find that all LCR banks tighten standards or terms except for full-banks in 2015-17 (column 3). Results for small firms are not significant (columns 4-6).

[21] Since we have fewer observations after merging the standards data with Y-9C, we have verified that the results in Table 2 continue to hold in the shorter sample (see Table D.1 in the appendix).

[22] Results from the regression are in Table D.2 of the appendix.

Banks tighten standards for many reasons. Conditional on tightening standards or terms, are LCR banks more likely than non-LCR banks to cite regulatory or supervisory concerns as reasons for doing so? The green-shaded bars in Figure 2 suggest that this may be the case. We set *RegTight* equal to 2 whenever *Stanterm* equals 1 *and* a bank cites regulatory or supervisory concerns; in all other cases, *RegTight* equals *StanTerm*. We model banks' choices using a multinomial logistic regression, estimated with maximum likelihood. $RegTight = 1$ is the reference category, and *Post-LCR*, *LCR-Bank*, *Post-LCR* $*$ *LCR-Bank* and bank controls are the regressors.

Panel A of Table 8 shows results when banks choose $RegTight = 2$ versus $RegTight = 1$ (i.e., whether banks implicate regulations when they tighten standards or terms).[23] The likelihood ratio test rejects the null that all coefficients are zero. The results for large (small) firms show that when *Post-LCR* $*$ *LCR-Bank* increases from 0 to 1, the log-odds for citing regulations when tightening increase significantly by 1.72 (2.12) units. Since the coefficients are difficult to interpret, Panel B of the table shows the estimated odds ratios which, due to the interaction term, are evaluated at different values of *Post-LCR* and *LCR-Bank*. The first two rows show results for the pre- and post-LCR periods. For large firms, the odds ratio of regulation-related tightening by LCR banks versus non-LCR banks is 1.69 after LCR (*Post-LCR* $= 1$) as compared to 0.30 before LCR (*Post-LCR* $= 0$), and the lower bound of the 95% confidence level is 0.61 after LCR as compared to 0.06 before LCR. For small firms, we have similar results, as the lower bound of the 95% confidence interval for the corresponding odds ratio is 0.57 after LCR as compared to 0.04 before LCR. Thus, the results are consistent with a greater likelihood of regulation-related tightening by covered banks relative to exempt banks after LCR, as compared to before LCR. The last two rows of Panel B show results for LCR and non-LCR banks. Regulation-related tightening is also more likely in the post- versus the pre-LCR period for LCR banks as compared to non-LCR banks, although the odds ratios are smaller in magnitude.

[23] Estimates for $RegTight = 0$ versus $RegTight = 1$ and $RegTight = -1$ versus $RegTight = 1$ are not shown to save space.

The survey question does not refer to LCR specifically, so could the results be due to capital regulations? To address this issue, we repeat the regression after replacing *Post-LCR* with a dummy variable *CapReg*=1 in 2011-2012 (since Basel III rules were released in December 2010) and 0 otherwise. The first two rows in Panel B of Table D.3 in the appendix show relatively *lower* likelihood of regulation-related tightening by LCR banks in the capital regulation period. For example, for large (small) firms, the odds ratio of regulation-related tightening by LCR banks versus non-LCR banks is 0.32 (0.07) when *CapReg*=1 as compared to 1.05 (1.27) when *CapReg*=0, and the lower bound of the 95% confidence level is 0.04 (0.01) when *CapReg*=1 compared to 0.41 (0.43) when *CapReg*=0. As such, our results are consistent with banks tightening standards or terms due to concerns specifically about LCR in addition to concerns about capital regulations.

7 Liquidity Creation by LCR and non-LCR Banks

Diamond and Kashyap (2016) note that, absent costs to limiting liquidity creation, the value of liquidity regulations cannot be assessed. Banks create liquidity by funding illiquid, long-maturity assets with liquid, short-term liabilities, thereby providing liquidity and maturity transformation services. Banks' primary asset-side adjustment to LCR, cutting loans in favor of HQLA, likely decreases their asset-side liquidity creation. However, since the LCR penalizes liquid liabilities differentially based on counterparty, collateral, and other factors, its effect on liability-side liquidity creation is unclear, per Hypothesis 4.

Our liquidity creation measure BB is taken from Berger and Bouwman (2009) and is equal to liquidity-weighted liabilities plus liquidity-weighted assets. Assets and liabilities are categorized as illiquid, semi-liquid or liquid and assigned fixed weights. Initially, we only use on-balance-sheet items (called "catnonfat" in Berger and Bouwman (2009)). To compare across bank size groups, we divide the change in BB by lagged assets and denote it BBN. In section E.1 of the appendix, we provide further implementation details, summary statistics and plots of liquidity creation by LCR and non-LCR banks.

In Table 9, we examine the effects of LCR on asset- and liability-side liquidity creation, and on each of the Berger and Bouwman (2009) liquidity categories. Mod-banks increase their share of liquid assets, which include HQLA (column 1), while all LCR banks decrease their shares of illiquid assets since 2013Q2, relative to non-LCR banks (column 3). Consistent with Hypothesis 4a, asset-side liquidity creation $BBNA$ by LCR banks decreases significantly (column 4). On the liability side, all LCR banks (except for mod-banks in 2013Q2-2014) decrease their shares of liquid liabilities relative to non-LCR banks since 2013Q2 (column 5), while changes in less-liquid liabilities are mostly not significant. Liability-side liquidity creation $BBNL$ is lower and significantly so in all cases except for mod-banks in 2013Q2-2014 (column 8). Driven mainly by declines in asset-side liquidity creation $BBNA$, overall balance sheet liquidity creation BBN by LCR banks decreases significantly in the post-LCR period, relative to non-LCR banks (column 9).

Considering alternative bank-size groupings, columns 2-4 of Table 5 show that decreases in *asset-side* liquidity creation and its components kick in at the \$50 billion cutoff but not below, once more indicating that the LCR dummy variables are not mere proxies for bank size. There is weaker evidence of an LCR effect on liability-side liquidity creation since the latter declines even in the $\$10-\$50$ billion size group, albeit at the 10% level of significance. Also consistent with a weaker effect of LCR on liability-side liquidity creation, when we include off-balance-sheet liabilities, our results remain unaffected (see Table E.4 in the appendix). We conclude that liquidity creation declines significantly after LCR, particularly on the asset-side, consistent with Hypothesis 4.

8 Fire-Sale Risk: LCR and Non-LCR Banks

The analysis has so far focused on the costs of LCR in terms of foregone lending and liquidity creation by covered banks. We now turn to the potential benefits from LCR banks' reduced contributions to fire-sale losses due to a lower concentration of illiquid assets (section 8.1). As we find that banks subject to LCR reduce their fire-sale externalities, we then quantify the benefits of LCR net of the costs associated with foregone lending (section 8.2).

8.1 Fire-Sale Risk of LCR and non-LCR Banks

The fire-sale risk measure is from Duarte and Eisenbach (2021) and captures spillovers following an asset price drop that increases bank leverage. After an initial shock to a bank's assets, other banks holding assets correlated with the "hit" bank also sell assets to return to their target leverage, and thereby suffer "second-round losses." A bank's contribution to fire-sale losses is the sum of all second-round spillover losses. As a share of assets, it depends on the concentration of large and illiquid assets (denoted illiquidity linkage) and its leverage relative to the system leverage at the time of the shock.[24] Lower loan shares of LCR banks, relative to non-LCR banks, may result in lower illiquidity linkages for LCR banks, as long as their portfolio similarity does not increase (Hypothesis 5). Leverage risk of LCR banks may increase due to lower loan shares (Duarte and Eisenbach (2021)), or decrease if banks delever to meet LCR requirements. However, leverage risk may also change in response to broad financial conditions. Therefore, we expect LCR to affect fire-sale risk primarily through the illiquidity component.

We estimate the the fire-sale measure for the largest 500 banks in the Y-9C data.[25] Figure 3 charts the fire-sale measure as a share of bank assets and its illiquidity linkage component. Table 10 shows the effects of LCR on changes in the fire-sale risk as a ratio of bank assets, and its illiquidity and leverage (expressed as a ratio of system leverage) components. LCR banks' contributions to overall fire-sale losses decrease significantly by 7 bp in 2013Q2-2014 and 8 bp in 2015-2017 (column 1) while those of full-banks decrease significantly by 11

[24] As we normalize by assets, the effect of size disappears (equation (9) in Duarte and Eisenbach (2021)).

[25] We do not use the full sample of Y-9C banks as the asset size cut-off for reporting purposes changes over time, resulting in large drops in the number of reporters in the later sample. Duarte and Eisenbach (2021) estimate their measure for the 130 largest banks. Also, to estimate the illiquidity linkage, we use the Net Stable Funding Ratio (NSFR) liquidity weights for the assets (see Internet Section V of Duarte and Eisenbach (2021)). We thank the authors for the fire-sale data and code.

bp and 13 bp, respectively (column 2). More important, relative to non-LCR banks, the illiquidity component is lower for LCR banks (column 3), and for *both* full- and mod-banks in 2013Q2-2014 and 2015-2017 (column 4). While the illiquidity component results are strongly significant, changes in the leverage component are mostly insignificant or, in one case, positive and significant (columns 5 and 6). Since, as previously stated, leverage risk may also change in response to broad financial conditions, we do not consider the change in leverage risk an effect of LCR. Hence, the results indicate greater resilience of LCR banks stemming from lower concentrations of large and illiquid assets.

Since capital regulations are unlikely to substantially affect the illiquidity linkage, the results in this section are compelling evidence of an LCR effect.

8.2 Net Benefits from LCR

We have thus far documented a private cost (regulated banks pass over potentially profitable lending opportunities) and a social benefit (regulated banks contribute less to systemic risk) of LCR. A natural next question to ask is whether the reductions in systemic risk contributions justify the costs imposed on regulated banks.[26]

We calculate the benefits in the post-LCR period – i.e., reduced illiquidity linkages of LCR banks, relative to non-LCR banks – from the estimates in columns 3-4 of Table 10. As the illiquidity component is unitless, we convert it into dollars by scaling by the post-LCR sample mean of (fire-sale losses/illiquidity component) for the relevant bank group. We approximate the costs of LCR by the income foregone from lower lending by LCR banks, relative to non-LCR banks. The loan income is defined to be the net interest income (NII) minus provisions for loan and lease losses (LLP), adjusted for taxes. We assume that, absent LCR, the average pre-LCR ratio of loan income to loans of LCR banks would remain the

[26]EBA (2013) finds the opportunity cost of LCR for European banks to be 1.8 bp of assets from lower returns on HQLA. Kara and Ozsoy (2020) show large increases in the price of risky assets from liquidity regulations. Hoerova, Mendicino, Nikolov, Schepens and Heuvel (2018) estimate the real effects of liquidity regulations using the spread between deposits and HQLA rates. Gam (2021) and Sundaresan and Xiao (2021) also consider the real effects of LCR.

same in the post-LCR period. Then, the foregone income of LCR banks equals this pre-LCR ratio multiplied by the estimated reduction in lending by LCR banks in the post-LCR period, relative to non-LCR banks. The post-LCR change in lending is obtained from specifications similar to those in columns 1 and 2 of Table 2. Details are in section F.1 of the appendix.

Panel A of Table 11 shows the pre-tax net benefits per bank-quarter from LCR. For LCR banks in the post-LCR period, the benefit from lower illiquidity concentration is 2.6 bp (column 2) and the net interest income foregone is 1.2 bp (column 3) for a net benefit of 1.4 bp (column 4) as a share of assets, which is statistically significant.[27] Most of the net benefits accrue to full-banks. In 2013Q2-2014, the net benefit to full-banks from lower illiquidity concentration is 2.6 bp (column 4) as a share of assets, or about $274 million per bank-quarter (last column) and amounting to about $23 billion when summed over 12 full-banks and 7 quarters. By comparison, the aggregate net benefit to mod-banks in 2013Q2-2014 is about $1.7 billion. For 2013Q2-2017, the net benefit to full-banks is about $40 billion as compared to only about $3.7 billion to mod-banks.

The aggregate after-tax net benefits are higher (Panel B) since taxes decrease the income foregone from loans but are assumed to have no effect on benefits. Total after-tax net benefits after LCR are about $53 billion for full-banks and $4 billion for mod-banks. Thus, only about 7% of net benefits accrue from regulating mod-banks. This is due to two reasons. First, the reduction in the illiquidity linkage is larger for full-banks (column 4 of Table 10). More important, full-banks contribute more to overall fire-sale risk in the banking sector so that the scaling factor $\frac{firesale\ risk}{illiquidity\ linkage}$ is substantially greater for mod-banks (Panel B of Table F.1 in the appendix). In other words, as full-banks are more systemic, a reduction in their fire-sale risk results in larger net benefits. This argument is bolstered by results reported in column 6 of Table 5 which show that reductions in the illiquidity component is insignificant below the $170 billion size bucket and strongest in bank size groups of $250 billion or higher. These results support recent initiatives by US regulators to exempt smaller banks from LCR.

[27]We calculate the standard error of net benefits as the square root of the sum of squares of the standard errors of benefits and costs.

9 Conclusion

In this paper, we examine the costs and benefits of the LCR as implemented in the US. We show that banks subject to the LCR increase their liquid assets and decrease their lending, as shares of total assets, in the post-LCR period, resulting in decreased asset-side liquidity creation relative to non-LCR banks. Banks with lower liquid asset shares prior to LCR decrease their loan shares by *more* following LCR. On the liability side, LCR banks reduce their shares of liquid borrowings relative to non-LCR banks. Consequently, liability-side liquidity creation also decreases, resulting in lower overall liquidity creation by LCR banks. Large LCR banks with lower pre-LCR shares of stable funding decrease their loan shares *less*, thus complying with LCR by increasing stable funding in lieu of cutting loans. Using microdata from SLOOS, we also show that LCR banks tighten lending standards or terms in the post-LCR period and frequently cite regulation or supervision as a reason for doing so, consistent with an LCR-induced credit supply shock.

While our estimated lending effects likely include components due to non-LCR regulations — such as stress tests, changes in the risk-weights from capital rules and the leverage ratio, CLAR or enhanced supervision — we argue that they are unlikely to account for all of the estimated effects. We show this by exploiting differences in the implementation and incidences of LCR and non-LCR regulations (for example, with respect to penalties on specific assets and the exemption status of certain banks).

While diminished credit supply by LCR banks is an unintended consequence of liquidity regulations, these costs are offset by the benefits from reduced fire-sale externalities due to a lower concentration of illiquid assets among LCR banks. We estimate that these net benefits exceed \$50 billion from 2013Q2 to 2017. However, these benefits accrue almost entirely to the largest LCR banks.

Other aspects of the costs and benefits from LCR remain unexplored. For example, an open question is whether the pre-LCR level of liquidity creation was socially excessive, in which case constraining it through regulation may have been optimal.

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Table 1: Asset- and Liability-Side Changes After LCR: Descriptive Statistics

The table shows select asset and liability items, as shares of total assets, for LCR and non-LCR banks before and after the finalization of LCR. High Quality Liquid Assets (HQLA) is an LCR-defined category and calculated based on LCR haircuts and caps. *Mod-Bank* are LCR banks with assets between $50 billion and $250 billion. *Full-Bank*, also subject to LCR, are internationally active or have assets exceeding $250 billion. Midsized banks are not subject to LCR and have assets between $3 billion and $50 billion.

Panel A: Assets

				Share of Total Assets (%)					
Size Group	Period	Number of Banks	Total Assets (Billions)	HQLA	HQLA Level 1	Structured Products	Loans	Fixed and Intangible Assets	Other Assets
All Banks	2009-2013Q1	109	117.69	11.14	7.55	1.87	60.89	8.73	17.37
	2013Q2-2014	109	125.28	9.70	6.69	1.63	62.71	7.98	17.98
	2015-2017	109	133.78	9.10	6.30	1.44	64.60	7.63	17.23
Full-Banks	2009-2013Q1	12	894.39	14.03	10.33	8.88	42.88	11.02	23.19
	2013Q2-2014	12	944.42	17.16	13.04	7.39	42.56	9.45	23.43
	2015-2017	12	984.05	19.72	14.78	5.87	42.38	8.65	23.39
Mod-Banks	2009-2013Q1	13	99.49	8.02	5.48	1.70	66.83	11.88	11.57
	2013Q2-2014	13	107.77	8.86	6.05	1.42	67.63	9.95	12.14
	2015-2017	13	125.04	10.98	7.02	1.04	66.40	9.33	12.25
Midsized Banks	2009-2013Q1	84	9.55	11.20	7.47	0.90	62.54	7.91	17.44
	2013Q2-2014	84	10.97	8.77	5.88	0.83	64.83	7.46	18.10
	2015-2017	84	13.66	7.30	4.98	0.87	67.49	7.22	17.12

Panel B: Liabilities

		Share of Total Liabilities (%)			
Size Group	Period	ON FedFunds	ON Repo	Insured Deposits	Core Deposits
All Banks	2009-2013Q1	0.45	4.58	42.83	60.95
	2013Q2-2014	0.32	3.37	42.06	66.63
	2015-2017	0.26	2.62	39.76	66.15
Full-Banks	2009-2013Q1	0.37	8.00	19.37	33.10
	2013Q2-2014	0.10	7.66	20.66	37.93
	2015-2017	0.04	6.00	21.15	38.87
Mod-Banks	2009-2013Q1	0.62	1.51	38.65	64.30
	2013Q2-2014	0.30	1.20	38.02	71.09
	2015-2017	0.27	1.35	36.26	69.89
Midsized Banks	2009-2013Q1	0.44	4.56	46.83	64.41
	2013Q2-2014	0.35	3.09	45.74	70.04
	2015-2017	0.30	2.33	42.96	69.46

Table 2: Changes in Bank Lending and LCR

The table shows results from estimating panel regressions (3) and (4) where the outcome variable is the change in loans, divided by the prior quarter's total assets. *LCR-Bank* is 1 for banks that were required to implement the LCR. *Mod-Bank* is 1 for LCR banks with assets between \$50 billion and \$250 billion. *G-SIB* is 1 for global systemically important banks. *Full-Bank* is 1 for LCR banks that are internationally active or have assets exceeding \$250 billion (excluding G-SIBs when the G-SIB dummy is included). We report $p - values$ from a $Wald$ test of the null hypothesis that the change in lending is equal for G-SIBs and non-GSIB full-banks. The omitted group is midsized banks, which have assets between \$3 billion and \$50 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively. C&I=Commercial & Industrial.

	(1) All Loans	(2) All Loans	(3) All C&I Loans	(4) Small Business C&I Loans	(5) All Loans	(6) All C&I Loans	(7) Small Business C&I Loans
	Without G-SIB Dummy Variable				With G-SIB Dummy Variable		
LCR Bank x 2013Q2-2014	-1.30***						
	(-3.72)						
Mod-Bank x 2013Q2-2014		-0.90**	-0.17	-0.04*	-0.90**	-0.17	-0.04*
		(-2.21)	(-1.46)	(-1.82)	(-2.21)	(-1.46)	(-1.81)
Full-Bank x 2013Q2-2014		-1.74***	-0.26**	-0.06***			
		(-4.69)	(-2.31)	(-2.81)			
Full (Non-G-SIB) x 2013Q2-2014 (α)					-1.88***	-0.21	-0.06**
					(-3.43)	(-1.45)	(-2.44)
G-SIB x 2013Q2-2014 (β)					-1.61***	-0.32***	-0.06***
					(-5.21)	(-3.07)	(-2.76)
LCR Bank x 2015-2017	-1.48***						
	(-4.12)						
Mod-Bank x 2015-2017		-0.97**	-0.29**	-0.03	-0.97**	-0.29**	-0.03
		(-2.05)	(-2.10)	(-1.18)	(-2.05)	(-2.11)	(-1.18)
Full-Bank x 2015-2017		-2.07***	-0.18	-0.07**			
		(-5.89)	(-1.39)	(-2.24)			
Full (Non-G-SIB) x 2015-2017 (γ)					-2.34***	-0.06	-0.06
					(-5.73)	(-0.29)	(-1.26)
G-SIB x 2015-2017 (δ)					-1.79***	-0.30***	-0.08***
					(-4.34)	(-3.26)	(-3.11)
Lag Tier 1 Capital Ratio	0.23***	0.24***	0.07***	0.01**	0.24***	0.07***	0.01**
	(3.60)	(3.67)	(3.90)	(1.99)	(3.66)	(3.90)	(1.99)
Lag Share Nonperforming Loans	-0.25***	-0.25***	-0.05**	-0.00	-0.25***	-0.05*	-0.00
	(-3.45)	(-3.42)	(-2.00)	(-0.70)	(-3.44)	(-1.98)	(-0.70)
Lag Net Interest Margin	-0.89	-0.90	-0.02	-0.15**	-0.91	-0.02	-0.15**
	(-1.35)	(-1.37)	(-0.11)	(-2.33)	(-1.39)	(-0.08)	(-2.31)
Lag Share Core Deposits	-0.01	-0.01	-0.00	-0.00*	-0.01	-0.00	-0.00*
	(-0.79)	(-0.83)	(-0.49)	(-1.85)	(-0.85)	(-0.46)	(-1.83)
Wald Test P-value: $\alpha = \beta$					0.59	0.30	0.94
Wald Test P-value: $\gamma = \delta$					0.22	0.32	0.58
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.06	0.06	0.05	0.02	0.06	0.05	0.02
Observations	3920	3920	3920	3379	3920	3920	3379

Table 3: Stress Testing, LCR and Changes in Bank Lending

The table shows results from panel regressions of changes in loans, as shares of total assets. LCR banks are split up into *late stress test* or LST banks that did not participate in stress tests till 2014 and the remaining LCR banks (denoted *early stress test* or EST banks) that participated in earlier stress tests (listed in Table C.5 in the appendix). We report $p-values$ from a $Wald$ test of the null hypothesis that the change in lending is equal for LST and EST banks in 2013Q2-2014. LCR banks are those with assets of at least $50 billion. The omitted group is midsized banks, which have assets between $3 billion and $50 billion. The sample period is 2009 Q1 to 2014 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively. C&I=Commercial & Industrial.

	All Loans	C&I Loans	
	(1)	(2)	(3)
		All	Small Business
LST Bank x 2013Q2-2014 (α)	-0.95**	-0.19	-0.07**
	(-2.23)	(-1.66)	(-2.56)
EST Bank x 2013Q2-2014 (β)	-1.55***	-0.22*	-0.04**
	(-4.14)	(-1.90)	(-2.14)
Lag Tier 1 Capital Ratio	0.24***	0.06***	0.02**
	(2.88)	(2.85)	(2.00)
Lag Share Nonperforming Loans	-0.30***	-0.07**	-0.00
	(-2.99)	(-2.36)	(-0.31)
Lag Net Interest Margin	-1.27	-0.02	-0.12
	(-1.56)	(-0.06)	(-1.34)
Lag Share Core Deposits	-0.02	-0.01	-0.00
	(-0.97)	(-0.95)	(-1.30)
Wald Test P-Value: $\alpha = \beta$	0.14	0.76	0.25
Bank F.E.	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes
Adj R^2	0.06	0.05	0.02
Observations	2612	2612	2071

Table 4: Changes in GNMA and GSE MBS Holdings and LCR

The table shows results from estimating panel regressions (3) and (4) where the outcome variable is the change in GNMA or GSE MBS, divided by the prior quarter's total assets. *LCR-Bank* is 1 for banks that were required to implement the LCR. *Mod-Bank* is 1 for LCR banks with assets between $50 billion and $250 billion. *Full-Bank* is 1 for LCR banks that are internationally active or have assets exceeding $250 billion. The omitted group is midsized banks, which have assets between $3 billion and $50 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) GNMA MBS	(2) GNMA MBS	(3) GSE MBS	(4) GSE MBS
LCR Bank x 2013Q2-2014	0.10*		-0.12	
	(1.69)		(-1.20)	
Mod-Bank x 2013Q2-2014		0.19**		-0.20
		(2.36)		(-1.29)
Full-Bank x 2013Q2-2014		-0.01		-0.04
		(-0.19)		(-0.46)
LCR Bank x 2015-2017	0.08**		-0.03	
	(2.05)		(-0.33)	
Mod-Bank x 2015-2017		0.10**		-0.09
		(2.13)		(-0.72)
Full-Bank x 2015-2017		0.05		0.03
		(0.99)		(0.34)
Bank F.E.	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes
Adj R^2	0.01	0.01	0.02	0.02
Observations	3920	3920	3920	3920

Table 5: Changes in Lending, Liquidity Creation and Fire-Sale Risk, Using Alternative Bank Size Groups

The table shows results from panel regressions of changes in various LCR-related outcomes, as shares of total assets: total loans (column 1), liquidity creation (columns 2-4) and fire-sale risk (columns 5-6). The on-balance sheet liquidity creation measure BBN (Berger and Bouwman (2009)) is decomposed into its asset-side ($BBNA$) and liability-side ($BBNL$) components. The overall fire-sale risk and its illiquidity component is from Duarte and Eisenbach (2021). *Post-LCR* is set equal to 1 from 2013 Q2 to 2017 Q4. Banks are grouped into \$40B size buckets starting from \$10B. Banks with assets ≥\$250B are split into G-SIBs (i.e., global systemically important banks) and non-G-SIBs.The omitted group includes banks with assets between \$3 billion and \$10 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) All Loans	(2) BBN	(3) BBNA	(4) BBNL	(5) Overall	(6) Illiquidity Component
10-50B x Post-LCR	-0.21	-0.41	-0.11	-0.30*	-0.02	-0.15
	(-0.54)	(-1.42)	(-0.53)	(-1.86)	(-0.95)	(-0.63)
50-90B x Post-LCR	-1.10***	-1.10***	-0.72***	-0.38***	-0.02	-0.55
	(-3.26)	(-4.77)	(-3.88)	(-2.84)	(-0.91)	(-1.53)
90-130B x Post-LCR	-1.12	-1.23*	-0.44	-0.79*	-0.09	-0.49
	(-1.18)	(-1.80)	(-1.27)	(-1.83)	(-1.43)	(-1.38)
130-170B x Post-LCR	-1.28	-1.16***	-1.14***	-0.03	-0.03	-0.46
	(-0.96)	(-2.92)	(-2.70)	(-0.16)	(-0.34)	(-0.75)
170-210B x Post-LCR	-1.23**	-0.88***	-0.65***	-0.24*	-0.11	-0.80***
	(-2.13)	(-4.50)	(-2.87)	(-1.81)	(-1.40)	(-4.27)
210-250B x Post-LCR	-2.57***	-0.80**	-0.67**	-0.13	-0.12	-1.38***
	(-2.96)	(-2.50)	(-2.11)	(-0.60)	(-1.51)	(-4.02)
≥250B x non-G-SIB	-2.22***	-1.68***	-1.14***	-0.53**	-0.13***	-1.44***
x Post-LCR	(-4.24)	(-6.30)	(-3.09)	(-2.04)	(-4.51)	(-6.17)
G-SIB x Post-LCR	-1.57***	-1.17***	-0.76***	-0.41***	-0.11***	-1.68***
	(-4.23)	(-3.91)	(-3.43)	(-2.90)	(-4.31)	(-4.67)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.07	0.06	0.07	0.06	0.10	0.46
Observations	3920	3920	3920	3920	3920	3920

Table 6: Heterogeneity in LCR Bank Lending: Effect of Pre-LCR Liquid Asset and Liability Shares

For the sample of LCR banks, Panel A of the table shows results from panel regressions of changes in total loans on *Post-LCR* $\times$ $(Z/Assets)_{2011Q1}$. *Post-LCR* is 1 from 2013 Q2 to 2017Q4. Z is an asset or liability item as of 2011Q1. In Panel B, we further interact the regressor with *Full-Bank* which is 1 for LCR banks that are internationally active or have assets exceeding $250 billion. The liability items are overnight (ON) fed funds, ON repo and insured deposits. The asset items are HQLA (high quality liquid assets, as defined by LCR) and Level 1 HQLA – the most liquid segment of HQLA. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	Z = ON Fed Funds	Z = ON Repo	Z = Insured Deposits	Z = Core Deposits	Z = HQLA	Z = Level 1 Assets
	(1)	(2)	(3)	(4)	(5)	(6)
Post-LCR x Z_{2011Q1}	0.10	0.00	0.02	0.01*	-0.01	-0.01
	(0.57)	(0.14)	(1.65)	(1.83)	(-0.55)	(-0.65)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.06	0.06	0.06	0.06	0.06	0.06
Observations	897	897	897	897	897	897

	Z = ON Fed Funds	Z = ON Repo	Z = Insured Deposits	Z= Core Deposits	Z = HQLA	Z = Level 1 Assets
	(1)	(2)	(3)	(4)	(5)	(6)
2013Q2-2014 x Z_{2011Q1} (δ_1)	0.24	-0.18**	0.04	0.04	-0.01	-0.03
	(1.64)	(-2.59)	(1.38)	(1.17)	(-0.18)	(-0.55)
2015-2017 x Z_{2011Q1} (δ_2)	-0.10	0.07	0.08**	0.04	-0.04	-0.05
	(-0.21)	(0.36)	(2.34)	(1.20)	(-1.25)	(-1.47)
Full-Bank x 2013Q2-2014	-0.15	0.24***	-0.06*	-0.04	0.03	0.05
x Z_{2011Q1} (γ_1)	(-0.86)	(3.18)	(-1.76)	(-1.39)	(0.55)	(1.06)
Full-Bank x 2015-2017	0.21	-0.03	-0.09**	-0.04	0.06	0.07*
x Z_{2011Q1} (γ_2)	(0.45)	(-0.17)	(-2.43)	(-1.30)	(1.61)	(1.83)
Full-Bank x 2013Q2-2014 (γ_3)	-0.73	-1.67***	1.10	1.69	-1.20	-1.30*
	(-1.59)	(-2.99)	(1.03)	(1.00)	(-1.49)	(-1.83)
Full-Bank x 2015-2017 (γ_4)	-1.07*	-1.15*	2.35*	1.71	-1.56**	-1.50**
	(-2.04)	(-2.00)	(1.87)	(0.80)	(-2.15)	(-2.21)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	897	897	897	897	897	897

Table 7: Changes in C&I Lending Standards or Terms: LCR and Non-LCR Banks

The dependent variable is *StanTerm*, the change in C&I lending standards or terms by banks. *StanTerm* equals 1 (-1) if both standards and terms are tighter (looser) or if one is tighter (looser) and the other is "no change," while it is 0 if both standards and terms are unchanged. In columns 1-3, the loans are to large firms. In columns 4-6, the loans are to small firms. Standards are coded as -1 (looser), 0 (no change) and 1 (tighter). *Residual* refers to residuals from a regression of *StanTerm* on loan demand, risk tolerance, macro and financial conditions. *2013Q2-2014* is set equal to 1 from 2013 Q2 to 2014 Q4 and *2015-2017* is set equal to 1 from 2015 Q1 to 2017 Q4. *LCR-Bank* is set equal to 1 for banks that were required to implement the LCR. *Mod-Bank* is set equal to 1 for LCR banks with assets between $50 billion and $250 billion. *Full-Bank* is set equal to 1 for LCR banks that are internationally active or have assets exceeding $250 billion. The omitted group is midsized banks, which have assets between $3 billion and $50 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	Large Businesses			Small Businesses		
	(1)	(2)	(3)	(4)	(5)	(6)
	Large	Large	Residual	Small	Small	Residual
LCR Bank x 2013Q2-2014	0.20**			0.09		
	(2.09)			(0.78)		
Mod-Bank x 2013Q2-2014		0.23*	0.17**		0.12	0.09
		(1.96)	(2.12)		(0.97)	(1.04)
Full-Bank x 2013Q2-2014		0.18	0.17**		0.02	0.03
		(1.59)	(2.16)		(0.12)	(0.32)
LCR Bank x 2015-2017	0.35**			0.21		
	(2.43)			(1.43)		
Mod-Bank x 2015-2017		0.48***	0.32***		0.22	0.16
		(3.32)	(3.12)		(1.58)	(1.55)
Full-Bank x 2015-2017		0.20	0.11		-0.03	-0.04
		(1.24)	(0.97)		(-0.14)	(-0.27)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.29	0.30	0.03	0.30	0.30	-0.00
Observations	1079	1079	1079	1006	1006	1006

Table 8: Changes in Lending Standards or Terms Related to Regulation

The table shows, for large and small firms, results from a multinomial logistic regression of *RegTight* on *Post-LCR*, *LCR-Bank* and *Post-LCR* $*$ *LCR-Bank* with *RegTight* $= 1$ as the reference category, along with bank controls. *RegTight* is coded as -1 when standards or terms are looser, 0 when there is no change, 1 when tighter for non-regulatory reasons and 2 when tighter due to regulatory or supervisory concerns. *Post-LCR* is set equal to 1 from 2013 Q2 to 2017 Q4. *LCR-Bank* is set equal to 1 for banks that were required to implement the LCR. The omitted group is midsized banks, which have assets between \$3 billion and \$50 billion. Panel A shows coefficient estimates when banks choose *RegTight* $= 2$ versus *RegTight* $= 1$. Estimates for "0" versus "1" and "-1" versus "1" are not shown. The likelihood ratio is a test of whether all regression coefficients are simultaneously zero. Panel B shows estimated odds ratios of citing regulations as a reason for tightening standards or terms for LCR versus non-LCR banks and pre- versus post-LCR periods. The sample period is 2010 Q3 to 2017 Q4. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Multinomial Logistic Estimates: *RegTight* $= 2$ versus *RegTight* $= 1$

	Large Firms			Small Firms		
	Estimate	Chi-Square	Prob>Chi-Square	Estimate	Chi-Square	Prob>Chi-Square
	(1)	(2)	(3)	(4)	(5)	(6)
LCR bank*Post-LCR	1.72*	3.58	0.06	2.12**	4.41	0.04
Post-LCR	-2.20***	8.61	0.00	-1.47**	3.79	0.05
LCR bank	-1.20	2.08	0.15	-1.45	2.44	0.12
Likelihood Ratio		175.76***	0.00		141.90***	0.00
Bank Controls?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1.442			1.395		

Panel B: Odds-Ratio Estimates and Wald Confidence Intervals

	Large Firms			Small Firms		
Odds Ratio of Citing regulation	Estimate	95% Confidence Intervals		Estimate	95% Confidence Intervals	
	(1)	(2)	(3)	(4)	(5)	(6)
Post-LCR $= 0$: LCR vs non-LCR bank	0.30	0.06	1.54	0.24	0.04	1.45
Post-LCR $= 1$: LCR vs non-LCR bank	1.69	0.61	4.73	1.97	0.57	6.75
LCR-Bank $= 0$: Post-LCR vs Pre-LCR	0.11	0.03	0.48	0.23	0.05	1.01
LCR-Bank $= 1$: Post-LCR vs Pre-LCR	0.62	0.21	1.87	1.92	0.41	8.88

Table 9: Assets, Liabilities and Liquidity Creation: LCR and Non-LCR Banks

The table shows results from estimating panel regressions of changes in liquid, semi-liquid, and illiquid assets and liabilities, along with the liquidity creation measure BBN and its asset- ($BBNA$) and liability-side ($BBNL$) components, all divided by lagged total assets. BBN is the on-balance sheet liquidity creation measure *cat nonfat* (Berger and Bouwman (2009)). The asset and liability liquidity categories are defined in Table E.1 in the appendix. *2013Q2-2014* is set equal to 1 from 2013 Q2 to 2014 Q4 and *2015-2017* is set equal to 1 from 2015 Q1 to 2017 Q4. *Mod-Bank* is set equal to 1 for LCR banks with assets between $50 billion and $250 billion. *Full-Bank* is set equal to 1 for LCR banks that are internationally active or have assets exceeding $250 billion. The omitted group is midsized banks, which have assets between $3 billion and $50 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	Δ Assets				Δ Liabilities				Δ Liquidity Creation
	(1) Liquid	(2) Semi-Liquid	(3) Illiquid	(4) BBNA	(5) Liquid	(6) Semi-Liquid	(7) Illiquid	(8) BBNL	(9) BBN
Mod-Bank x 2013Q2-2014	0.81***	-0.35*	-0.71	-0.76***	-0.41	0.22	-0.08	-0.17	-0.93***
	(2.86)	(-1.95)	(-1.62)	(-2.91)	(-1.47)	(0.67)	(-0.53)	(-1.53)	(-3.04)
Full-Bank x 2013Q2-2014	0.48	-0.62**	-1.33***	-0.91***	-0.97***	-0.20	-0.23	-0.37**	-1.28***
	(1.35)	(-2.54)	(-3.89)	(-3.72)	(-2.82)	(-0.78)	(-1.61)	(-2.19)	(-5.92)
Mod-Bank x 2015-2017	0.66***	-0.19	-0.79*	-0.73***	-0.76**	0.41	0.02	-0.39***	-1.12***
	(3.54)	(-0.97)	(-1.88)	(-3.32)	(-2.42)	(1.37)	(0.15)	(-3.29)	(-3.77)
Full-Bank x 2015-2017	0.38	-0.50**	-1.79***	-1.09***	-1.11***	-0.45*	-0.32***	-0.40***	-1.48***
	(1.38)	(-2.51)	(-4.88)	(-4.97)	(-3.74)	(-1.80)	(-3.86)	(-2.89)	(-6.02)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.04	0.03	0.04	0.07	0.03	0.05	0.03	0.05	0.05
Observations	3920	3920	3920	3920	3920	3920	3920	3920	3920

Table 10: Fire-Sale Risk of LCR and Non-LCR Banks

The table shows results from panel regressions of changes in the overall fire-sale risk (i.e., the contribution of a bank to fire-sale losses in the banking sector, as a share of the bank's assets) and its two components: illiquidity and leverage. *2013Q2-2014* is set equal to 1 from 2013 Q2 to 2014 Q4 and *2015-2017* is set equal to 1 from 2015 Q1 to 2017 Q4. *Mod-Bank* is set equal to 1 for LCR banks with assets between $50 billion and $250 billion. *Full-Bank* is set equal to 1 for LCR banks that are internationally active or have assets exceeding $250 billion. The omitted group is midsized banks, which have assets between $3 billion and $50 billion. The sample period is 2009 Q1 to 2017 Q4. Standard errors are clustered at the bank-level. t statistics are shown in parenthesis. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

	(1) Overall	(2) Overall	(3) Illiquidity Component	(4) Illiquidity Component	(5) Leverage Component	(6) Leverage Component
LCR Bank x 2013Q2-2014	-0.07***		-0.56***		-0.01	
	(-2.88)		(-2.92)		(-0.44)	
Mod-Bank x 2013Q2-2014		-0.03		-0.43**		0.01
		(-0.93)		(-2.28)		(0.78)
Full-Bank x 2013Q2-2014		-0.11***		-0.70**		-0.03
		(-5.19)		(-2.40)		(-1.26)
LCR Bank x 2015-2017	-0.08***		-1.31***		0.03	
	(-3.52)		(-5.31)		(1.17)	
Mod-Bank x 2015-2017		-0.05		-1.11***		0.06**
		(-1.50)		(-4.78)		(2.14)
Full-Bank x 2015-2017		-0.13***		-1.54***		0.01
		(-5.73)		(-3.95)		(0.13)
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.09	0.10	0.46	0.46	0.53	0.53
Observations	3920	3920	3920	3920	3920	3920

Table 11: Net Benefits after LCR

The table shows the net benefits from LCR, equal to the benefits of reduced illiquidity concentrations (resulting in lower fire-sale externalities) minus costs due to the income foregone from less lending, by LCR banks relative to non-LCR banks. The estimated benefits are from columns 3 and 4 of Table 10, scaled by the average ratio of fire-sale losses to illiquidity (to convert to dollars). The loan income is the net interest income (NII) minus provisions for loan and lease losses (LLP), adjusted for taxes. To obtain the foregone income, the average pre-LCR ratio of loan income to loans of LCR banks is multiplied by the estimated reduction in lending by LCR banks, relative to non-LCR banks, during the post-LCR period. Panel A shows the the pre-tax net benefits from LCR. Panel B shows the after-tax net benefits from LCR. *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Pre-Tax Net Benefits

			Share of Assets (Basis Points)			Total ($Millions)		
		(1)	(2)	(3)	(4)	(1)*(2)	(1)*(3)	(1)*(4)
Group	Period	Mean Assets ($Billions)	Benefit	Cost	Benefit - Cost	Benefit	Cost	Benefit - Cost
LCR Banks	Post-LCR	513.82	2.61	1.21	1.40***	134.07	61.98	72.10***
LCR Banks	2013Q2-2014	493.83	3.26	1.09	2.17***	160.93	53.66	107.27***
Full-Banks	2013Q2-2014	1051.48	4.21	1.60	2.61***	442.35	168.34	274.01***
Mod-Banks	2013Q2-2014	107.77	2.37	0.61	1.76***	25.53	6.60	18.93***
LCR Banks	2015-2017	525.47	2.24	1.28	0.96*	117.95	67.24	50.71*
Full-Banks	2015-2017	1103.87	3.11	2.02	1.10**	343.65	222.67	120.98**
Mod-Banks	2015-2017	125.04	1.66	0.66	1.00*	20.74	8.29	12.45*

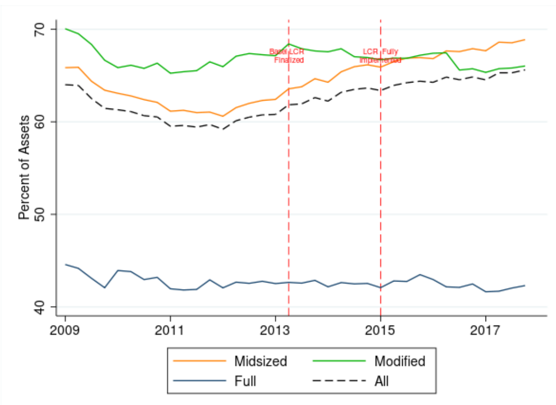
Panel B: After-Tax Net Benefits

			Share of Assets (Basis Points)			Total ($Millions)		
		(1)	(2)	(3)	(4)	(1)*(2)	(1)*(3)	(1)*(4)
Group	Period	Mean Assets ($Billions)	Benefit	Cost	Benefit - Cost	Benefit	Cost	Benefit - Cost
LCR Banks	Post-LCR	513.82	2.61	0.87	1.74***	134.07	44.61	89.46***
LCR Banks	2013Q2-2014	493.83	3.26	0.78	2.48***	160.93	38.63	122.30***
Full-Banks	2013Q2-2014	1051.48	4.21	1.15	3.06***	442.35	121.04	321.30***
Mod-Banks	2013Q2-2014	107.77	2.37	0.44	1.93***	25.53	4.78	20.75***
LCR Banks	2015-2017	525.47	2.24	0.92	1.32***	117.95	48.40	69.54***
Full-Banks	2015-2017	1103.87	3.11	1.45	1.66***	343.65	160.11	183.54***
Mod-Banks	2015-2017	125.04	1.66	0.48	1.18**	20.74	6.01	14.73**

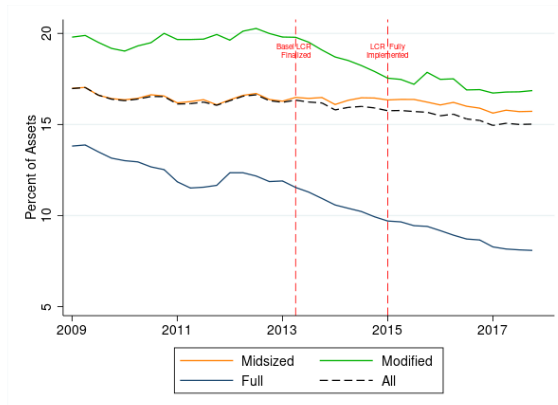
Figure 1: Share of Loans in Total Assets: LCR and Non-LCR Banks

The top panel plots total loans and residential real estate loans as shares of assets, averaged over all banks (dashed line) or over banks in different size groups (solid lines). The middle panel plots the shares of commercial real estate and C&I loans, and the bottom panel plots shares of small business C&I loans. Banks with assets $\geq$ \$50 billion are required to implement the LCR rule. Full-banks are internationally active or have assets exceeding \$250 billion. Mod-banks have assets between \$50 billion and \$250 billion. Midsized banks have assets between \$3 billion and \$50 billion and are not subject to the LCR rule. The sample period is 2009 Q1 to 2017 Q4.

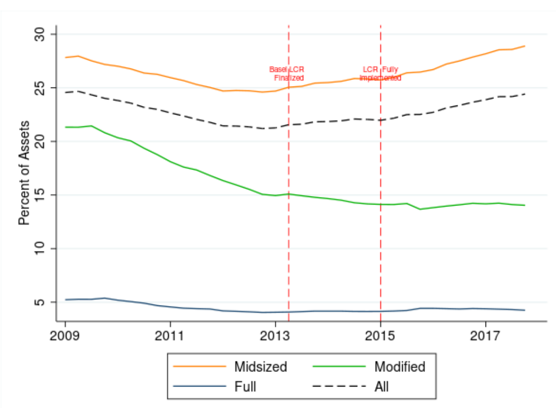
Total Loans



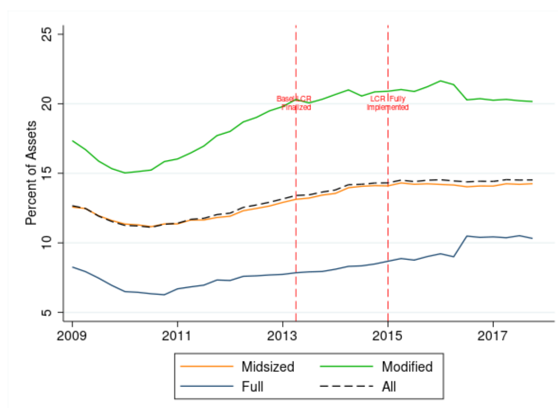
Residential Real Estate



Commercial Real Estate



C&I Loans



Small Business C&I Loans

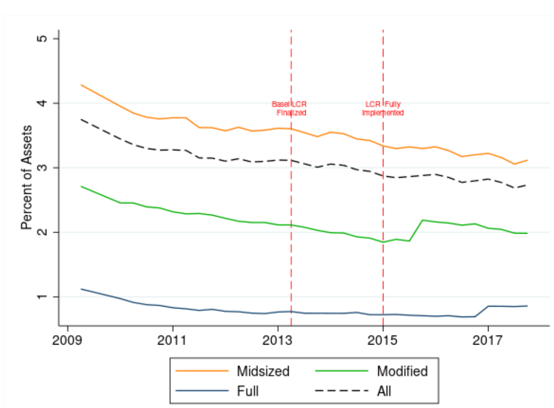
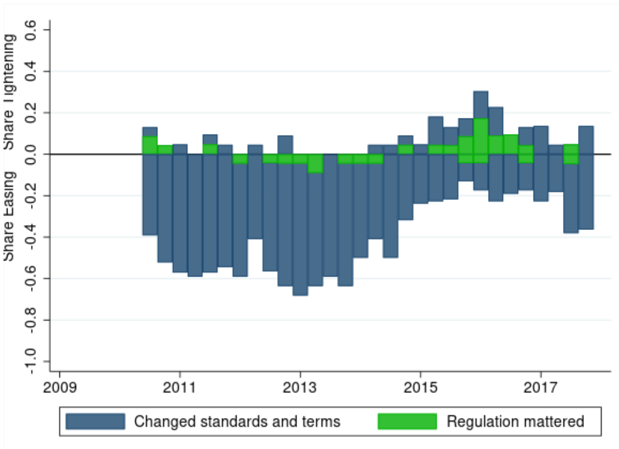


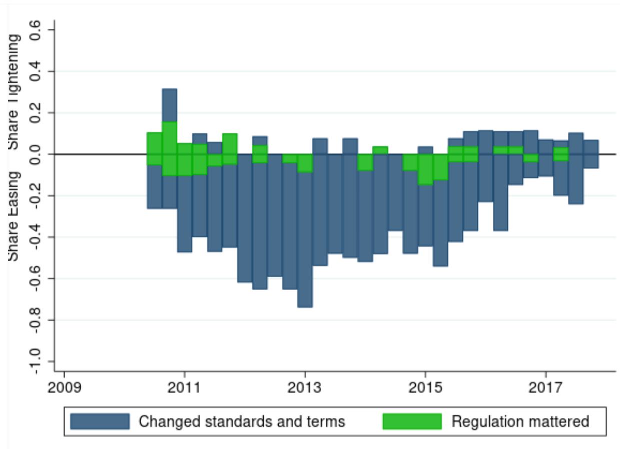
Figure 2: Lending Standards, Terms and Regulation: C&I Loans to Small and Large Firms

The blue shaded bars in the figure show the share of banks that indicated that they either tightened or eased lending standards or terms to small firms (top panel) or large firms (bottom panel) for C&I loans in the Senior Loan Officer Opinion Survey. The green-shaded areas show the share of banks indicating regulatory, supervisory or accounting changes as the reason for tightening or easing. "LCR Banks" have assets exceeding $50 billion and are required to implement the LCR rule. Midsized banks have assets between $3 billion and $50 billion are not subject to the LCR rule. The sample period is 2010 Q3 to 2017 Q4.

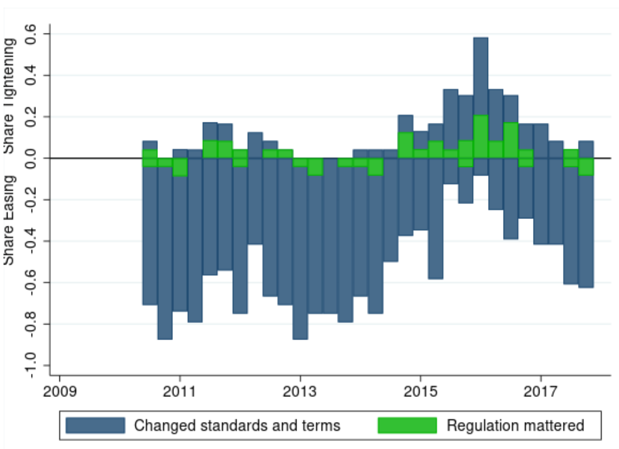
Small firms: LCR Banks



Small firms: Midsized Banks



Large firms: LCR Banks



Large firms: Midsized Banks

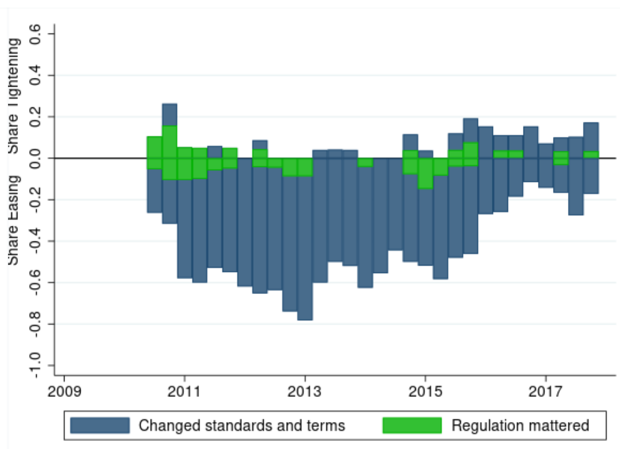


Figure 3: Fire-Sale Risk and Its Illiquidity and Aggregate Components: LCR and Non-LCR Banks

The top left panel of the figure shows the contribution of a bank to fire-sale losses in the banking sector (scaled by $1e^{-15}$), as a share of the bank's assets, averaged over banks in different size groups. The top right panel shows the illiquidity component of fire-sale risk scaled by $1e^{15}$. The bottom panel shows the aggregate (not bank-specific) component of fire-sale risk. Banks that have assets exceeding \$50 billion are required to implement the LCR rule. Full-banks are internationally active or have assets exceeding \$250 billion. Mod-banks have assets between \$50 billion and \$250 billion. Midsized banks have assets between \$3 billion and \$50 billion are not subject to the LCR rule. The sample period is 2009 Q1 to 2017 Q4.