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Abstract

We examine liquidity creation per unit of assets by banks subject to the Liquidity Coverage Ratio (LCR) using the liquidity measures Liquidity Mismatch Index (LMI) (Bai et al., 2018) and *BB* (Berger and Bouwman, 2009). We identify the LCR effects through time and cross-section effects, specific LCR-constrained balance sheet categories, an economically similar asset pair with different LCR weights, and the differential implementation of LCR by the very large and less-large LCR banks. We find that, since 2013, there has been reduced liquidity creation by LCR banks compared to non-LCR banks, occurring mostly through greater holdings of liquid assets and lower holdings of illiquid assets. Trends in liquid asset holdings are driven by High Quality Liquid Assets (HQLA), an LCR-defined category, particularly for assets where market and LCR liquidity weights are most similar. Of particular interest is a post-LCR shift in LCR bank portfolios to GNMA MBS rather than GSE MBS, economically similar assets with different LCR weights, that is not attributable to relatively greater issuances or relative price effects. We also find sharper declines of commercial and residential real estate loans by LCR banks relative to non-LCR banks post-2013. Finally, we find a decline in the high run-off category of LCR liabilities for LCR banks relative to non-LCR banks post-2013 for the largest LCR banks with greater than $250 billion in assets. Our results highlight the trade-off between lower liquidity creation and lower run risk from reduced liquidity mismatch of the largest banks.

Key words: LCR, banks, liquidity creation

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To view the authors’ disclosure statements, visit https://www.newyorkfed.org/research/staff_reports/sr852.html.

1 Introduction

What makes banks special? One answer is that banks are skilled at liquidity and maturity transformation (LMT) by funding illiquid, long-maturity assets with liquid, short-term liabilities–in particular, demandable deposits (Diamond and Dybvig (1983) and Holmstrom and Tirole (1998)). For example, there might be a natural synergy between the asset and liability sides of banks (Calomiris and Kahn (1991), Flannery (1994), Diamond and Rajan (2001), Kashyap et al. (2002), and Hanson et al. (2015)). By issuing risky loans against riskless deposits, however, banks also take on risk (Diamond (1984), Ramakrishnan and Thakor (1984) and Boyd and Prescott (1986)) that makes them susceptible to fragility, especially during periods of financial crisis.

Since large banks create the most liquidity (Berger and Bouwman (2009)), the tradeoff between liquidity creation and fragility is most consequential for them. This has motivated recent liquidity regulations such as the Liquidity Coverage Ratio (LCR) which requires bank holding companies ("banks" from now on) with assets exceeding \$50 billion ("LCR banks" from now on) to hold enough unencumbered high quality liquid assets (HQLA) that can be easily and quickly converted into cash within 30 days during a period of financial stress. Within their HQLA portfolios, banks must hold a minimum amount of the most liquid assets (so-called Level 1 assets) and abide by caps on the extent to which less liquid assets (so-called Level 2A and Level 2B assets) are eligible as HQLA. Affects not eligible as HQLA do not count towards LCR. Banks with less than \$50 billion in assets ("non-LCR" banks from now on) are not subject to the LCR.

The effect of the LCR on liquidity creation depends on bank responses to the regulation. Since, prior to its implementation, most banks did not meet LCR requirements, the direct effect of LCR may be to reduce the liquidity mismatch (as intended) and thus, by definition, reduce liquidity creation by LCR banks. However, because the liquidity preferences of banks and LCR differ, banks have an incentive to undo the direct effects, as further discussed in section 3.2. For example, within their non-HQLA portfolio, banks may increase the portfolio weights of low-liquidity assets. Even within a particular HQLA liquidity level, banks may substitute relatively less liquid or higher maturity assets for liquid, short-maturity assets. Thus, whether liquidity creation decreases or not for LCR banks, is an empirical matter.

In this paper, we examine liquidity creation by LCR and non-LCR banks using the liquidity measures Liquidity Mismatch Index (LMI) (Bai et al. (2018)), and BB (Berger and Bouwman (2009)), focusing mainly on the on-balance-sheet versions of both measures. Similar to LCR, the measures, are defined as liquidity-weighted liabilities minus liquidity-weighted assets, with the liquidity weights either derived from market prices (as with LMI) or pre-specified (as with BB). We divide both measures by total assets (denoted LMIN and BBN) to compare liquidity creation across banks of different sizes. Liquidity creation is defined as the summed product of book-value weights time the liquidity weight, where the latter reflects the liquidity preference of the regulator (for LCR), the market (for LMI) or the researcher (for BB). Since the measures differ on how they define liquidity categories, we first define common balance sheet categories (e.g. HQLA or particular liability items). Then, we identify the effect of LCR on book-value weights for this category. Finally, we apply the liquidity weights to estimate the effect of LCR on liquidity creation under alternative liquidity preferences.

We identify the LCR effects in several ways. The first uses the time of LCR implementation (since 2013) and cross-section effects (i.e. LCR applies only to bank holding companies with total assets greater than \$50 billion). Second, we use specific LCR-constrained balance sheet categories — HQLA on the asset side and, on the liability side, items that are grouped by their “runnability.” Third, within the HQLA portfolio, we take advantage of an asset pair that is economically similar (e.g. they have the same LMI liquidity weight) but are assigned different LCR weights. Finally, we exploit the differential implementation of LCR for so-called full LCR banks with assets greater than \$250 billion (who had to start implementation by January 2015) and mod-LCR banks with assets between \$50 billion and \$250 billion (who had to start implementation by January 2016).

We find that, since 2013, there has been either reduced (per $LMIN$) or flat (per BBN) liquidity creation by LCR banks compared to non-LCR banks. By comparison, large non-LCR banks (those with assets between \$3 billion and \$50 billion) and smaller banks increased liquidity creation since 2013. Indeed, since 2015 LCR banks have created less liquidity than non-LCR banks per unit of assets–a historic reversal in the role of liquidity transformation. The reduction in liquidity creation occurs mostly on the asset side of the balance sheet, in that there is greater holdings of liquid assets and lower holdings of illiquid assets by LCR banks post-2013, as compared to non-LCR banks. On the liability side, changes in liquidity-weighted liabilities are similar for all bank size groups post-2013.

To further identify the asset-side LCR effects, we decompose the asset-side measures into its HQLA and non-HQLA components. Since HQLA is a purely LCR-defined asset category, trends in these components are likely driven directly by LCR effects. Consistent with this idea, we find that trends in book-value weights are driven by the HQLA portion of the balance sheet as they increase for LCR banks as compared to non-LCR banks since 2013. Across HQLA liquidity levels, we find greater book-value weight changes for Level 1 assets and least for Level 2B assets. This is consistent with expectations since the difference between LCR weights and LMI or BB weights are minimal for Level 1, so that banks have a greater incentive to satisfy HQLA by holding more Level 1 assets (see equation 9). By comparison, market and regulator liquidity weights differ most Level 2B assets, and book value weights increase least for LCR banks in this category. The LCR-weighted change in HQLA for LCR banks post-2013 is less than the LMI-weighted changes, reflecting the lower regulatory preferences for less liquid HQLA such as Level 2B assets.

Considering individual assets within each HQLA level, we find a greater preference for reserves within Level 1 assets. Since the different liquidity weights are essentially the same for Level 1 assets, this difference may reflect banks' preference for the greater safety and convenience of reserves as compared to US Treasuries and other Level 1 assets. Of particular interest is a shift in LCR bank portfolios post-LCR to GNMA MBS (a Level 1 asset) rather than GSE MBS (a Level 2A asset). These assets are economically similar with an identical LMI weight. This shift cannot be explained by relatively greater issuances of GNMA or relative price effects. Hence, the result is indicative of an LCR effect on bank portfolio choice.

Finally, we examine liquid liabilities and illiquid assets, the components of traditional bank liquidity creation. We find decreased holdings of loans by LCR banks relative to non-LCR banks post-2013, particularly commercial and residential real estate loans.

Considering liabilities, we find a decline in the high run-off LCR categories by LCR banks relative to non-LCR banks post-2013. These loans are short maturity and volatile, which makes them more runnable. However, this effect is confined to the largest LCR banks with greater than $250 billion in assets as mid-sized LCR banks increase their holdings of high run-off liabilities. Instead, the mid-sized LCR banks appear to adjust to LCR by reducing their holdings of illiquid assets more substantially than the largest LCR banks, particularly after 2015 Q1.

Lower liquidity mismatch of LCR banks is arguably a desired consequence of liquidity regulations. Where, then, would liquidity creation come from? We find that non-LCR banks created more liquidity but not enough to offset the effects on LCR banks. Proponents of narrow banks (i.e. banks that hold assets with low interest rates and credit risk against demandable deposits) might argue that non-bank financial intermediaries are best positioned to create liquidity (Gorton and Pennacchi (1990) and Pennacchi (2016)). In their view, illiquid assets observed on contemporary bank balance sheets are evidence of moral hazard created by deposit insurance and too-big-to-fail debt guarantees. Since the LCR mandates liquid assets and liabilities (i.e. a narrow banking balance sheet), it mitigates the historical distortions created favor of illiquid assets by government internventions.

To empirically assess the tradeoffs from liquidity regulations, we require an estimate of their benefits in terms of enhanced resilience against run risk. Indeed, decreased liquidity creation by large banks may itself be a response to greater perceived firesale risk coming out of the crisis, since theory suggests that it is optimal for banks to hold more liquid assets in such circumstances (see, for example, Hanson et al. (2015)). Estimating this tradeoff is the subject of ongoing research.

In addition to LCR, the largest banks also face, since 2012, liquidity stress tests-formally known as Comprehensive Liquidity Assessment and Review (CLAR). Similar to the capital stress tests, CLAR is an annual process whereby each bank supplies information regarding its own internal liquidity stress test, assesses the liquidity needs of its business activities and reviews the assumptions behind its assessment of available liquidity. For some banks, the liquidity stress tests may be more binding than LCR (Elliott (2014)). Thus, our results may be viewed as due to liquidity regulations generally, rather than solely to LCR.

During the post-2008 period, enhanced capital regulation was also put in place. How can effects due to capital and liquidity regulations be distinguished? Increased bank capital may either impede liquidity creation by reducing the incentives of bank to monitor borrowers (Diamond and Rajan (2000) and Diamond and Rajan (2001)) or by crowding out deposits (Gorton and Winton (2000)). Alternatively, higher capital may increase banks' risk absorbing capacity and increasing liquidity creation (Bhattacharya and Thakor (1993) and Coval and Thakor (2005)). Berger and Bouwman (2009) argue (and show empirically) that the latter effect dominates for large banks who are exposed to greater market discipline and regulatory scrutiny, and therefore enhanced capital regulation should favor liquidity creation by large banks. Kashyap et al. (2017) considers a setting where credit risk and run risk endogenously interact. Capital regulations result in lower lending and liquid asset holdings while the opposite is true for liquidity regulations. In sum, the literature is consisent with the interpreation that our results are attributable to liquidity rather than capital regulations.

The remainder of the paper is organized as follows. Section 2 provides background on LCR. In section 3, we describe the data and methodology, and develop hypotheses on LCR effects. Results on the effect of LCR on overall liquidity creation, and its asset and liability components, are reported in section 4. LCR effects on liquid assets are in section 5. LCR effects on illquid assets (loans) and liquid liabilities are in section 6. Full and mod-LCR banks are compared in section 7. Section 8 concludes the article.

2 LCR Background and Literature Review

2.1 LCR Background

The Liquidity Coverage Ratio (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 LCR of an institution is defined as the institution's holdings of High Quality Liquid Assets (HQLA) divided by total expected net cash outflows ($ENCO30$) over a 30 calendar day window in a stress scenario. For bank i in period t:

$$LCR_{i,t} = \frac{HQLA_{i,t}}{ENCO30_{i,t}} \tag{1}$$

LCR was created to ensure that participants in the banking sector would have adequate liquid assets in the event of a hypothetical 30-day period of high stress on the liabilities side of the balance sheet. In introducing this liquidity measure and the corresponding regulatory requirements, the Committee intended to address contagion risk that resulted from liquidity shortages at systemically important institutions during the 2007-2008 financial crisis. The Basel III actions were followed by the U.S. introduction of LCR, first proposed in October 2013, and finalized on September 2014.

Implementation of the LCR in the U.S. varies by the total amount of consolidated assets a Bank Holding Company (BHC) holds. BHCs with over $250 billion in consolidated assets are required to meet a full 100% LCR. Also, BHCs with over $10 billion in foreign exposure, and depository institutions that are subsidiaries of covered BHCs with over $10 billion in consolidated assets are subject to the full-LCR. BHCs with over $50 billion but less than $250 billion in consolidated assets are subject to a modified-LCR, with the net outflow denominator discounted to 70 percent of its full level. BHCs with consolidated assets under

$50 billion are not subject to the rule.

The implementation timeline of LCR in the U.S. was accelerated for banks subject to the full-LCR relative to those subject to the modified-LCR, and both timelines remained ahead of Basel III deadlines which require 100% LCR by 2019. Starting in January 2015, firms subject to the full LCR were required to submit a daily LCR to regulatory authorities, while modified LCR firms submit monthly. If an institution required to abide by the full LCR falls below 100% on any business day after 2017, the institution must notify its supervising agency. If an institution sees over three consecutive shortfall days, it must submit a "plan for remediation" with a timeline for compliance. For the largest BHCs, i.e. those with over $700 billion in consolidated assets, a required quarterly public disclosure began in April 2017. Figure 1 shows the time line of LCR implementation across the different BHCs size groups.

The U.S. LCR rule defines HQLA assets as non-financial assets with a low risk profile, with a large market, without sharp historical price declines, and readily valued and converted to cash in times of stress. Central bank eligibility is also a helpful signifier, but not a prerequisite or independently sufficient condition for a qualifying asset. Specifically, an asset must be "Liquid and Readily-Marketable" (LRM), meaning that it has at least two market makers, many non-market makers, readily observable prices, and high trading volumes.

Assets qualifying under the above rules are designated into three categories, Level 1, Level 2A, and Level 2B. Table 6 summarizes the broad asset classes qualifying under each category. Level 1 assets have to constitute at least 60 percent of an institution's total HQLA stock, while the sum of Level 2A and 2B assets cannot exceed 40 percent. Level 2B on its own cannot exceed more than 15 percent of its total HQLA stock. The excess HQLA amounts for the sum of 2A and 2B or 2B alone can be calculated on an unadjusted or adjusted basis. The adjusted basis has the same level caps but are based on the fair value of qualifying assets after unwinding transactions that mature within 30 days. The greater of the unadjusted excess and the adjusted excess is subtracted from the sum of the Level 1, 2A, and 2B assets to calculate the total HQLA amount. Moreover, total HQLA amount is capped at the outflows of the primary subsidiary. That is, the amount of HQLA held at subsidiaries that is included in the consolidated company's calculation is limited to the amount that would be available to transfer without restrictions to the top-tier company during times of liquidity stress.

2.2 Literature Review

Banks may under-provide liquidity due to moral hazard (Tirole (2006)) or negative externalities when banks don't account for the systemic effects of their own actions (Freixas et al. (2000), Allen and Gale (2000) and Brunnermeier (2009)). To prevent financial instability and to protect small depositors (who are less able to monitor opaque bank assets) from individual bank failures, liquidity regulation is justified in such cases.[1]. In order to deal with the micro- and macro-prudential consequences, Rochet (2008) proposes a two-part liquidity ratio, a uniform part to deal with individual bank failures and a second part that varies with a measure of macro shock.

Is the optimal liquidity regulation similar in spirit to the LCR? In an incomplete market setting, Allen and Gale (2004) find that a liquidity floor improves over the competitive market allocation, but they do not show this to be an optimal regulation. Farhi et al. (2009) study liquidity regulation in a Diamond and Dybvig (1983) framework. Agents can trade in private markets after they are allocated consumption profiles. Efficient liquidity insurance provision requires that the present value of resources are redistributed in favor of early consumers (who have a higher marginal utility of income following a liquidity shock). A social planner can implement the constrained efficient allocation by requiring a minimum share of short-term assets in intermediary portfolios. The liquidity floor increases resources in the early period and drives down interest rates in the private market, which is desirable for incentive purposes.

The form of the liquidity regulation typically depends on bank characteristics. Thus, Farhi et al. (2009) find that, if intermediaries are heterogeneous, then the optimal liquidity

[1]Ex-ante liquidity regulations may also be needed to offset ex-ante moral hazard caused by ex-post lender of last resort interventions (Cao and Illing (2010))

floor depends on intermediary characteristics. Perotti and Suarez (2011) conclude that, when banks differ according to their incentives to take on risk, quantity-based liquidity regulation, such as the LCR, is effective as it limits lending. In contrast, if banks differ by their lending capacities, then a Pigouvian tax is less distortionary than the LCR. In the latter situation, the LCR may impose large deadweight costs (which is equal to the liquidity buffer per unit of short-term funding times the yield spread between short-term assets and liabilities).

How do liquidity and capital regulations interact? Kashyap et al. (2017) consider a setting where credit risk and run risk endogenously interact. Capital regulations result in lower lending and liquid asset holdings while the opposite is true for liquidity regulations. In a general equilibrium model, Adrian and Boyarchenko (2017) find that liquidity requirements result in higher household welfare than capital requirements by reducing systemic risk without impairing consumption growth. Our results suggest that reduced liquidity creation by LCR banks may be a channel whereby consumption growth is adversely affected by liquidity regulations.

3 Liquidity Measures, Hypotheses Development and Methodology

We describe and compare the BB and LMI measures in section 3.1. Then, we relate these measures to LCR and thereby develop hypotheses about the channels through which an LCR-effect on liquidity creation may be identified (section 3.2). Finally, we discuss the empirical methodologies pursued in this paper (section 3.3).

3.1 Data and Liquidity Creation Measures

We use the Berger-Bouwman measure BB (Berger and Bouwman (2009)) and the LMI measure (Bai et al. (2018)) liquidity measures. We use the on-balance sheet versions of the measures (denoted catnonfat for BB) since activities in off-balance sheet items are dominated by the largest banks, and are minimal for small banks with assets below $3 billion, making size-based comparisons less reliable. Off-balance sheet items are discussed in section 7.

Both measures define liquidity as the difference of liquidity weighted assets and liabilities. However, they differ in how the liquidity weight is estimated and how the balance sheet items are categorized (see Tables 2 and 3).[2] We use balance sheet information obtained from the FR Y-9C report for creating the measures.[3]

The BB measure for bank i and quarter t is defined as:

$$
\begin{aligned}
BB_{i,t} &= \sum_{j=1}^{m} \lambda_{a,j} A_{ijt} + \sum_{k=1}^{n} \lambda_{l,k} L_{ikt} \\
&= BBA_{i,t} + BBL_{i,t}
\end{aligned} \tag{2}
$$

where $\lambda_{a,j}$ and $\lambda_{l,k}$ are the weights for asset item A_j and liability item L_k, respectively. The weights $\lambda_{a,j}$ and $\lambda_{l,k}$ are fixed over time at pre-assigned values {-1/2, 0, +1/2} with illiquid assets and liquid liabilities receiving positive weights and, conversely, liquid assets and illiquid liabilities receiving negative weights. Semi-liquid items receive zero weight. Weights for the BB measures are taken from Table 1 of Berger and Bouwman (2009).

LMI for bank i and quarter t is defined as:

$$
\begin{aligned}
LMI_{i,t} &= -\sum_{j=1}^{m} \lambda_{a,jt} A_{ijt} + \sum_{k=1}^{n} \lambda_{l,kt} L_{ikt} \\
&= -LMIA_{i,t} + LMIL_{i,t}
\end{aligned} \tag{3}
$$

We have reversed the signs in (3 from the Bai et al. (2018) definition so that positive values of BB and LMI both indiate more liquidity creation. Different from BB, the liquidity

[2] For example, LMI treats all loans as one category while BB differentiates between loan types. Conversely, BB treats cash, ABS and corporate bonds identically while LMI does not. In addition, some off-balance-sheet items are excluded from the LMI calculations.

[3] Berger and Bouwman (2009) use Call Reports, which has data for bank subsidiaries, rather than Y-9C which has data for BHCs. Since LCR applies to BHCs, we continue to use Y-9C but verify that we match values in Berger and Bouwman (2009) when using Call Reports data.

weights are time-varying with market prices. λ_a is derived from repo haircuts and λ_l from the OIS-Tbill spread, as described in Appendix A of Bai et al. (2018). The repo haircut data is from the SEC Edgar website before 2010 and from the Federal Reserve Bank of New York since 2010Q1.[4] Loan haircuts for the secondary loan market is from the Loan Syndications & Trading Association, `www.lsta.org`. The OIS and Tbill data are from Bloomberg.

For comparing across banks in different asset size groups, we divide the liquidity measure Y by total assets to obtain YN for bank i and quarter t:

$$YN_{i,t} = \frac{Y_{i,t}}{A_{i.t}}, Y = \{BB, BBA, BBL, LMI, LMIA, LMIL\} \tag{4}$$

To obtain Y for a particular group of banks, we take the mean of YN for each bank in the group. If there are n banks in size group k, then:

$$YN_{k,t} = \frac{\sum_{j=1}^{n} YN_{k,j,t}}{n}, Y = \{BB, BBA, BBL, LMI, LMIA, LMIL\} \tag{5}$$

We construct a balanced panel of US banks for the sample 2009 Q1 to 2017Q4, consisting of banks that survivied throughout the sample. Thus, new entrants within the samples are discarded as are BHCs that were acquired by a non-panel bank. Foreign banks are excluded as they did not report data to FR Y-9C till 2016.[5]

3.2 Hypotheses Development

In this section, we develop hypotheses intended to capture balance sheet changes if banks passively adjust to LCR, without attempting to optimize their portfolios based on market prices and other factors. These are benchmarks for interpreting our results – deviations from them indicate to what extent banks adjust their portfolios to minimize LCR effects.

[4]`https://www.newyorkfed.org/banking/tpr_infr_reform_data.html`

[5]Since 2016, foreign banking organizations with $50 billion or more in US assets have been required to place virtually all of their US subsidiaries under a US Intermediate Holding Company (IHC). The IHCs report data to FR Y-9C but we cannot include them due to their late entry in the sample.

It is useful to express LCR as the difference in liquidity weighted assets and liabilities. For convenience, denote Level 2A as Level 2 and Level 2B as Level 3. From equation (1):

$$
\begin{aligned}
Log(LCR_{i,t}) &= Log(HQLA_{it}) - Log(ENCO30_{it}) \\
HQLA_{it} &= \sum_{j=1}^{3} \lambda_{hj} \sum_{k=1}^{n_j} A_{ijkt} \\
ENCO30_{it} &= \sum_{j=1}^{s} \lambda_{rj} ENCO30_{ijt}
\end{aligned}
\tag{6}
$$

where for bank i in quarter t, λ_{hj} is the liquidity weight for level j of HQLA and A_{jk} is the book value (BV) of asset k in level j, and λ_{rj} is the runoff rate attached to outflow j.

For simplicity, assume that LCR implies separate requirements on assets and outflows– say, a minimum H^* of HQLA and a maximum O^* of outflows by time t:

$$
\begin{aligned}
HQLA_{it} &>= H_t^* \\
ENCO30_{it} &<= O_t^*
\end{aligned}
\tag{7}
$$

Suppose that each bank has liquidity preference identical to the market-implied weights of LMI.[6] Then, consider a bank with $HQLA_{i0} < H_t^*$ at t=0:

$$
HQLA_{i0} = \sum_{j=1}^{3} \sum_{k=1}^{n_j} \lambda_{mjk0} A_{ijk0} < H_t^* \tag{8}
$$

where, for asset k in level j, λ_{mkj0} is the LMI weight and A_{ikj0} is the BV of the asset.

To satisfy LCR, the bank needs additional HQLA per unit of total assets equal to:

$$
\Delta h_{it} = \frac{H_t^*}{A_{it}} - \frac{HQLA_{i0}}{A_{i0}} = \sum_{j=1}^{3} \sum_{k=1}^{n_j} \{w_{ijk0}(\lambda_{hj} - \lambda_{mjk0}) + \lambda_{hj}(w_{ijkt} - w_{ijk0})\} > 0 \tag{9}
$$

where $w_{ijkt} = \frac{A_{ijkt}}{Ait}$ is the portfolio weight of asset k.

[6]While this may be plausible for banks in the aggregate, individual banks are likely to have different preferences than the market. We ignore this issue in our discussion.

Hypothesis 1: BV changes in response to HQLA. (1) Banks have a strong incentive to meet Level 1 requirements by increasing the BV weights of these assets. (2) For level Level 2A and 2b assets, banks have a weak incentive to increase their book value weights.

Table 1 shows that the difference in LCR and LMI weights is 0.03 for Level 1, implying a small value for the first term in equation 9. The marginal benefit of increasing the BV weight of asset j is λ_{hj}, from the second term in equation 9, close to the banks' own benefit λ_{mjk}. For Level 2A and Level 2B assets, $0.96 = \lambda_{mjk} > \lambda_{hj} = 0.85$ and $0.79 = \lambda_{mjk} > \lambda_{hj} = 0.5$ and so the marginal value of increasing w_{ijk0} is smaller than the banks' private benefit. Moreover, the first term is now negative, and so the book value weights have to increase a lot to satisfy equation 9.

Hypothesis 2: Banks have a stronger incentive to increase book value weights of Agency Debt and MBS than GSE debt and MBS, even though they have identical LMI weights.

From Table 2, Agency and GSE debt and MBS have LMI weight of 0.96 but the LCR weight is 1 for the former and 0.85 for the latter. Therefore, $\lambda_{mjk} > \lambda_{hj}$ for GSE securities and $\lambda_{mjk} \simeq \lambda_{hj}$ for Agency securities. Then, Hypothesis 2 follows from equation 9.

The change in liquidity-weighted HQLA, using LMI weights, is:

$$\frac{HQLA_{it}}{A_{it}} - \frac{HQLA_{i0}}{A_{i0}} = \sum_{k=1}^{n_j} \sum_{j=1}^{3} \{w_{ijkt}(\lambda_{mjkt} - \lambda_{mjk0}) + \lambda_{mjk0}(w_{ijkt} - w_{ijk0})\} \tag{10}$$

The first term is the effect of time-variation in the LMI liquidity weights.

Hypothesis 3: LMI-weighted HQLA. (1) if LMI weights don't decrease over time, then LMI-weighted HQLA is likely to increase for Level 1 assets. (2) if LMI weights don't increase over time, then LMI-weighted HQLA is likely to decrease for Level 2A and 2b assets.

Under (1), the first term in equation 10 is non-negative and so is the second term (see Hypothesis 1). Conversely, under (2), both terms in equation 10 are non-positive.

The difference between LMI-weighted and LCR-weighted HQLA changes is:

$$\frac{HQLA_{it}}{A_{it}} - \frac{H_t^*}{A_{it}} = \sum_{k=1}^{n_j}\sum_{j=1}^{3}(w_{ijkt}(\lambda_{mjkt} - \lambda_{hj}) \tag{11}$$

Hypothesis 4: Difference between LMI-weighted and LCR-weighted HQLA. (1) Changes in LMI-weighted and LCR-weighted HQLA are similar for Level 1 and Level 2A assets. (2) LMI- weighted HQLA is higher than LCR-weighted HQLA for Level 2B assets.

The result follows directly from equation 11 and Table 1.

Next, consider NHQLA, the non-HQLA portion of assets. From equation (7), the HQLA requirement implies a ceiling for NHQLA assets:

$$NHQLA_{it} <= \sum_{a=1}^{n_a} \lambda_{mat} A_{iat} - H_t^* \tag{12}$$

where A_{ia} and λ_{ma} are the BV and the liquidity weight under LMI of asset a. Suppose that, at time t=0, the bank has excess NQHLA and so needs to deleverage by:

$$\begin{aligned}\Delta nh_{it} &= \frac{HQLA_{it} + NHQLA_{it} - H_t^*}{A_{it}} - \frac{NHQLA_{i0}}{A_{i0}} \\ &= \frac{NHQLA_{it}}{A_{it}} + \sum_{k=1}^{n_j}\sum_{j=1}^{3}\lambda_{mjkt}w_{ijkt} - \sum_{k=1}^{n_j}\sum_{j=1}^{3}\lambda_{hj}w_{ijkt} - \frac{NHQLA_{i0}}{A_{i0}} < 0\end{aligned} \tag{13}$$

From equation (13), the effect on liquidity-weighted NHQLA is:

$$\frac{NHQLA_{it}}{A_{it}} - \frac{NHQLA_{i0}}{A_{i0}} = \Delta nh_{it} + \sum_{k=1}^{n_j}\sum_{j=1}^{3} w_{ijkt}(\lambda_{hj} - \lambda_{mjkt}) \tag{14}$$

Hypothesis 5: Liquidity-weighted NHQLA. Liquidity-weighted NHQLA is more likely to increase the higher the proportion of HQLA in Level 1 assets and the lower in Level 2B assets.

For Level 1 (2a and 2b) assets, the second term in equation 14 is positive (negative). Since $\Delta nh_{it} < 0$, the RHS of (14) is more likely to be positive when the portfolio weight of Level 1 assets is large. Investing in Level 2B assets is particularly likely to decrease liquidity-weighted NHQLA as the difference in liquidity weights is large.

Hypothesis 6: Liquidity-weighted Assets. Liquidity-weighted assets are more likely to increase the higher the proportion of HQLA in Level 1 assets and the lower in Level 2B assets.

A high proportion of HQLA in Level 1 (2b) is more likely to increase (decrease) both liquidity-weighted HQLA and NHQLA (see Hypothesis 3 and 5). Increasing the BV weights of Level 2A assets is ambiguous as it's more likely to result in higher liquidity-weighted HQLA and lower liquidity-weighted NHQLA. The following is an example where liquidity-weighted assets *decrease* after HQLA.

Example: Lower liquidity-weighted assets after HQLA. Suppose the bank holds 3 assets with initial holdings {4, 8, 8} with LMI weights $\lambda_m = \{1, 1, 0.5\}$ and fixed in time. Liquidity-weighted assets are (4+8+4)=16. Suppose that under LCR, assets 1 and 2 qualify as HQLA Level 1 and 2a, with weights 1 and 0.85, and the weighted sum must be at least 11. Assume that bank size and book values are both fixed. Suppose the bank sells 8 units of asset 2 and buys 11 units of asset 1 and an additional unit of asset 3. So HQLA=11 and liquidity weighted assets are 11 + 4.5 = 15.5 and so liquidity-weighted assets have decreased!

The arguments for the outflow requirement O_t^* are parallel to of those for HQLA, with the exceptions that the inequality sign in equation (7) is flipped. However, since we don't have numerical values of outflows, we can only make qualitative predictions.

Hypothesis 7: Liquidity-weighted Liabilities. Liquidity-weighted liabilities are more likely to decrease the higher the proportion of liabilities in high run-off categories and the lower in lower run-off categories of liabilities.

3.3 Methodology

We identify structural breakpoints in the variables of interest to examine if they coincide with the period of LCR implementation. The breakpoints are determined using the sequential methodology of Bai (1997), assuming that the dates are not known, and allowing for a maximum number of breaks of 5. The procedure involves the sequential application of breakpoint tests. Beginning with the full sample, and then sequentially for each subsample, we perform a test of parameter constancy with unknown break. A breakpoint is added whenever the null hypothesis of no breakpoint is rejected in a subsample. The procedure is repeated until, in every subsample, the null hypothesis is not rejected, or until the maximum number of breakpoints allowed is reached.

Next, we estimate panel regressions using a diff-in-diff specification to exploit both the time of LCR implementation and its differential effects across banks in different size groups. Following our discussion in section 3.2, we show the effects of LCR on book values, the liquidity weights and the overall effect. The basic specification is:

$$\begin{aligned} Y_{it} = \alpha_0 + \gamma_1 \textit{Post-LCR}_t + \gamma_2 \textit{LCR-Bank}_{it} + \gamma_3 \textit{Mid-Sized}_{it} + \sum_{j=1}^{m} \beta_{ij} X_{ijt} \\ + \delta_1 \textit{Post-LCR}_t * \textit{LCR-Bank}_{it} + \delta_2 \textit{Post-LCR}_t * \textit{Mid-Sized}_{it} + \epsilon_{it} \end{aligned} \quad (15)$$

where Y is the outcome variable, and X are bank-level controls (e.g. bank type–whether the bank is a processor, investment or retail bank, core deposits/liability, duration, net interest margin, leverage and the number of subsidiaries of holding company). *Post-LCR* is a dummy variable equal to 1 from from 2013Q2 to 2017Q4 and 0 otherwise. *LCR-Bank* $= 1$ for banks with assets exceeding \$50 billion and *Mid-Sized* $= 1$ for banks with assets between \$3 billion and \$50 billion. The omitted group has banks with assets less than \$3 billion. We also estimate 15 with bank and time fixed effects. The standard errors are clustered by bank size group and robust to heteroskedasticity and serial correlation.

In a refinement, we distinguish between between full LCR banks (with assets more than \$250 billion) who had an accelerated implementation schedule and modified LCR banks (with assets between \$50 billion and \$250 billion) who had more time to adjust to LCR implementation. In addition, we split the $PostLCR$ period dummy to before and since

2015Q1. Since full LCR banks had to publicly disclose their LCR by 2017Q2, they started to adjust to LCR values prior to 2015 (Ihrig et al. (2017)) and were fully compliant by 2016. In contrast, modified LCR banks were only required to be compliant by 2017.

$$
\begin{aligned}
Y_{it} = \alpha_0 &+ \gamma_1 \textit{2013-2015}_t + \gamma_2 2015+_t + \gamma_3 \textit{Full-LCR}_{it} + \gamma_4 \textit{Mod-LCR}_{it} + \gamma_5 \textit{Mid-Sized}_{it} \\
&+ \delta_1 \textit{2013-2015}_t * \textit{Full-LCR}_{it} + \delta_2 2015+_t * \textit{Full-LCR}_{it} \\
&+ \delta_3 \textit{2013-2015}_t * \textit{Mod-LCR}_{it} + \delta_4 2015+_t * \textit{Mod-LCR}_{it} \\
&+ \delta_5 \textit{2013-2015}_t * \textit{Mid-Sized}_{it} + \delta_6 2015+_t * \textit{Mid-Sized}_{it} + \sum_{j=1}^{m} \beta_{ij} X_{ijt} + \epsilon_{it} \qquad (16)
\end{aligned}
$$

4 Liquidity Creation by LCR and non-LCR Banks

We compare liquidity creation, using BBN and $LMIN$, by LCR banks (assets greater than \$50 billion), mid-sized non-LCR banks (assets between \$3 billion and \$50 billion) and smaller banks (assets below \$3 billion). The top chart of figure 2 shows that BBN follows parallel trends for the 3 groups between 2004 and 2013, rising before the crisis, then falling till 2011 and recovering from 2011 to 2013. In 2003, BBN was highest for the largest banks, indicating that the largest banks provided the most liquidity per dollar of asset, consistent with Berger and Bouwman (2009).[7] However, the trends diverge from 2013 as BBN is flat for LCR banks while it keeps increasing for non-LCR banks. A similar dynamic is visible for LMIN (bottom chart). All 3 bank size groups create liquidity going into the crisis and reduce liquidity after the crisis, till 2013. During this period, LCR banks create the most liquidity per dollar of assets. Since 2013, while non-LCR banks resume liquidity creation, the LCR banks continue to reduce liquidity creation, narrowing the gap between LCR and non-LCR banks. By 2015 (when banks with assets greater than \$ 250 billion start to implement the LCR), the gap in liqudity creation had closed. More recently, the LCR banks have provided less liquidity per dollar of assets compared to the other two groups. Notably, since mid-sized non-LCR banks

[7] Since Berger and Bouwman (2009) include off-balance-sheet assets and define large banks as those with greater than \$ 3 billion in assets, the comparison is approximate.

continue to create liquidity, this result is not related to asset size alone.

We estimate breakpoint tests on ΔBBN and $\Delta LMIN$ for each of the three groups. The results are in the appendix and show that, in addition to the expected crisis period structural breaks, both series show additional breaks in 2013 Q2 and 2015Q1, corresponding to the LCR rule finalization period and the start of the implementation period, respectively.

We estimate the panel regression (15) with ΔBBN and $\Delta LMIN$ as dependent variables. To abstract from crisis period effects, we estimate the regression from 2009Q1. The first 3 columns of Table 4 show results for BBN. LCR banks significantly reduced liquidity creation by 61 basis points (bp) per quarter compared to 32 bp for non-LCR banks. Total liquidity creation by LCR banks in the post-LCR period (obtained by adding coefficients of the LCR-Bank-related variables, the Post-LCR dummy variable and the constant) was 2 bp and statistically insignificant. In contrast, liquidity creation by mid-sized non-LCR banks was 39 bp and statistically significant, and the difference in liquidity creation is significant (last row of table). The result is robust to including a bank fixed effect (column 3). A similar result obtains for LMIN (last 3 columns of table) except that there is a statistically significant in *reduction* liquidity creation by LCR banks, compared to no liquidity creation using BBN.

While both measures indicate reduced liquidity creation by LCR banks since 2013, does this occur mainly on the asset or liability sides? Figure 3 shows the asset and liability side measures $\frac{\lambda_a A_a}{A}$ and $\frac{\lambda_l L_l}{L}$, respectively (see equations 2 and 3). Higher values indicate more liquidity creation (i.e. lower liquidity-weighted assets and higher liquidity-weighted liabilities). The top panel plots the $BBNA$ and $BBNL$ measures. We find reduced liquidity creation on the asset side for LCR banks compared to non-LCR banks since 2013, with parallel trends for all bank size groups prior to 2013. On the liabilities side, by comparison, we find similar trends in reduced liquidity creation for all bank size groups. The bottom panel plots $-LMINA$ and $LMINL$. LCR banks create the most liquidity on the asset side till 2013 when non-LCR banks catch up and, after 2014, surpass LCR banks in asset-side liquidity creation. Liquidity-weighted liabilities of LCR banks move in line with non-LCR banks except after 2016.

Reduced asset-side liquidity creation may occur as banks increase the share of liquid assets or reduce the share of illiquid assets, such as loans. To examine this issue, we group assets into liquid and illiquid buckets using the BB definitions (Table 2). Figure 4 indicates increased liquid asset holdings and decreased illiquid asset holdings by LCR banks since 2013, as compared to non-LCR banks.

Panel regression results are in Table 5. Changes in $BBAN$ and $-LMIAN$, in columns (1) and (2) of the table, show an increase in liquidity-weighted assets by LCR banks compared to non-LCR banks, and the difference in statistically significant. Columns (3) to (5) of the table indicate an increase in the share of liquid assets and a decrease in the share of semi-liquid and illiquid assets of LCR banks, relative to non-LCR banks. The difference is statistically significant for liquid and illiquid assets (last row of table). Columns (6) and (7) show no significant effect for liquidity-weighted liabilities of LCR banks. Considering liabilities of different liquidity, we find an increase in the share of semi-liquid liabilities of LCR banks compared to non-LCR banks, implying increased relative holdings of time deposits and long-maturity commercial paper (Table 3). Overall, the main drivers of decreased liquidity creation by LCR banks are relatively greater liquid assets and lower illiquid assets holdings, with some effects from individual liability items.

Our results so far suggest that changes in liquidity creation are related to LCR because they are specific to LCR banks around the time of LCR implementation. Moreover, the LCR-induced changes in liquidity creation mainly occur on the asset side of the balance sheet. However, differences in liquidity weights and categories between the measures (Tables 2 and 3) make it difficult to further pin down the LCR effects. Therefore, we next fix categories, and examine specific LCR-related balance sheet items within these categories.

5 Book-Value and Liquidity-Weighted Changes of LCR and non-LCR Bank Liquid Assets

For fixed asset categories, we consider book value changes and liquidity-weighted changes separately, and thereby assess liquidity creation for alternative liquidity preferences. We explore changes in HQLA, an LCR-constructed category, in this section and illiquid assets in section 6.. Within HQLA liquidity levels, banks have an incentive to shift assets to take advantage of differences in LMI and LCR liquidity weights (see Table 2). Thus, we further examine individual assets within HQLA levels. Of particular interest are GNMA and GSE MBS, economically close substitutes that are treated differently in LCR (the former as a Level 1 asset with zero haircut and the latter as a Level 2A asset with 20% haircut). Thus changes in portfolio weights of these securities speak directly to LCR effects.

We consider BV weights of HQLA and its levels. The HQLA portfolio is constructed according to Table 1, taking into account the asset eligibility criteria as well as the cap on Level 2A and 2b assets (for example, no more than 15% of a bank's Level 2B asset was included in HQLA). In the first panel of Figure 5, we find that LCR and mid-sized banks have parallel increasing trends in HQLA BV weights prior to 2013. Since then LCR banks increase their holdings while mid-sized banks decrease their holdings of HQLA assets. Small banks decrease their HQLA weights since 2010. The next panels of Figure 5 plot trends in HQLA levels. Consistent with hypothesis 1, the BV weight increases of LCR banks relative to non-LCR banks are most for Level 1 and least for Level 2B. Thus, relative trends in HQLA are driven by Level 1 and Level 2A assets. For Level 1 asset weights, LCR banks show an increasing trend since 2009 that accelerates from 2013 whereas the other groups have decreasing trends even prior to 2013. An explanation, consistent with the breakpoint test results, is a shift to safe assets by the largest banks since the crisis with a further shift in 2013. For Level 2A asset weights, all size groups have parallel trends till 2013, after which the trend is flat for LCR banks and decreasing for non-LCR banks. The dynamics of Level

2B asset weights appear similar for all 3 groups.

The first column of Table 6 shows higher HQLA BV weights for LCR vis-a-vis non-LCR banks during the post-LCR period. The total change in BV weights in the LCR period is positive for LCR banks and negative for mid-size banks and this difference is statistically significant (last row of table). Columns (2) - (4) of Table 6 show that LCR banks increase BV weights for each level and, moreoever, the coefficient of the LCR Bank-Post-LCR intereaction term is highest for levels 1 and least for Level 2B, consistent with hypothesis 1. In the post LCR period, the total effects for LCR banks are positive for Level 1 assets and flat for Level 2A and 2b assets while, for mid-sized banks, the total effect is negative for all levels, and the difference is statistically significant for all levels. Overall, the results mostly align with hypothesis 1, suggesting that bank HQLA portfolio choices were consistent with a relatively passive adjustment to LCR with minimal efforts to shift assets between HQLA levels (for example, to maximize risk-adjusted returns or to meet a returns target).[8].

The final 2 columns of Table 6 show the effect of applying LMI and LCR liquidity weights to HQLA. The increase in HQLA weights for LCR banks is higher using the LMI weights than with LCR weights, reflecting the fact that the average HQLA weight is 0.91 for LMI and 0.78 for LCR. If we scale the HQLA BV changes for each level by the associated LCR weights, the predicted coefficient is 0.65, higher than the estimate of 0.56. This difference may reflect the ceiling on holdings for HQLA levels 2a and 2b–e.g., Level 2B assets must be less than 15% of the HQLA portfolio and any additional amounts receive a liquidity weight of 0 (see Table 1).

Banks have some freedom in putting greater weight on higher yielding assets within a level. For example, while banks must hold at least 60% of their HQLA in Level 1, they may choose to hold more GNMA MBS and less reserves to satisfy these requirements. Thus, we consider the HQLA items separately to examine LCR bank choices of asset weights within HQLA levels. The book-value regression results are in Table 7. For Level 1 assets, the

[8]Note, however, that the amount of Level 2A and 2b assets are further constrained by the amount of so-called "trapped liquidity," which is an indicator of the holding company's obligation to its subsidiaries.

difference in weights (LCR-LMI) is 0 for reserves, and 0.04 for Treasuries, Agency Debt and GNMA MBS (Table 2). LCR bank BV weights in the Post-LCR period increase substantially for reserves, moderately for GNMA MBS and show minimal or no statistically significant change for other Level 1 assets. Thus, LCR banks show a clear preference for reserves over other Level 1 assets in spite of similar weight differences, which may reflect a desire for safety or an effect of the Fed's asset purchases.[9] Of particular interest is the shift in LCR bank portfolios to GNMA MBS (a Level 1 asset) with no corresponding shift to GSE MBS (a Level 2A asset), although they are economically similar and with identical LMI weight of 0.96. Consistent with hypothesis 1, LCR banks BV weight of GNMA MBS increases 8 bp in the post-LCR period with no statistically significant change in BV weights for GSE MBS. LCR banks also experience an increase in BV weights of GSE debt (a Level 2A asset) and munis (a Level 2B asset) in the Post-LCR period.

In Table 8, we further explore the relative change in book value weights of GNMA and GSE portfolio weights. In particular,the regression includes the change in the GNMA issuance share and also the change in the GNMA - GSE yields at issuance. We find that these variables are significant and negative for changes in GSE MBS portfolio weights, indicating that changes in GSE MBS BV weights decrease when the GSE MBS issuance share decreases and when GSE issuance yields increase relative to GNMA issuance yields. However, it remains true that, for LCR banks in the Post-LCR period, the BV weight of GNMA MBS increases but not the weight of GSE MBS. This result illustrates how economically similar assets with different LCR weights were treated differently in bank portfolios.

Hanson et al. (2015) find that, in their pre-LCR balance sheets, commercial banks held few agency and Treasury securities but large amounts of agency MBS, CMOs and CMBs, corporate and municipal bonds. The results in this section show that large banks who now hold relatively large shares of liquid assets while small and mid-sized banks do the opposite.

[9] Between 2010 and 2014, the Fed conducted some of its major Large Scale Asset Purchase (LSAP) activity, resulting in an increase in reserves on aggregate bank balance sheets. However, this need not imply a correlation between LSAP and reserve holdings for individual banks or groups of banks.

6 Changes in Illiquid Assets and Liquid Liabilities of LCR and non-LCR Bank Liabilities

In this section, we examine the components of traditional bank liquidity creation – illiquid assets (section 6.1) and liquid liabilities (section 6.2). Previously, we found relative decreases in illiquid asset holdings of LCR banks in the Post-LCR period. In this section, we focus on the main loan categories —commerical and industrial (C&I), commerical real estate (CRE), residential real estate (RRE) and consumer loans. Regarding liabilities, we previously found no effects on LCR bank liabilities but there might be LCR effects on particular liability items. In particular, LCR assigns run-off rates to different categories of liabilities (see Table 3). Shorter maturity and more volatile liabilities are penalized with higher run-off rates, leading to lower LCR values. Therefore, banks have an incentive to reduce their reliance on high-runoff liabilities.

6.1 Changes in Bank Loans for LCR and non-LCR Banks

We focus on C&I, CRE, RRE, consumer loans and SBL in this section. As before, we first consider changes in the book-value weights and then changes in the liquidity-weighted book values. Table 9 reports the regressions results for changes in book-value weights of loans in the illiquid and semi-liquid categories (following the BB categories in Table 3). We find a significant decrease in BV weights of LCR banks in the Post-LCR period for CRE and RRE loans, but no significant change in the BV weight of C&I loans or consumer loans. By comparison, *Mid-Sized* banks reduce their BV weights in C&I and RRE loans. Overall, we find a decrease in BV weights of LCR banks in the Post-LCR period for CRE and RRE loans, relative to *Mid-Sized* banks, but a relative increase in C&I loans.

Of the other loan types, there is a decrease in LCR-bank holdings of agricultural loans and loans to other depository institutions. The latter result implies reductions in inter-bank borrowing and, anticipating future results, we also find reductions in other types of short-term funding, such as repo sold and fed funds purchases.

Overall, we find a decline in the relative share of LCR banks in the Post-LCR period for illiquid assets and total loans. However, while this is also true for some categories of loans (CRE and RRE, for example), for other loan categories – mainly C&I and SBL – there is a relative increase in the share of LCR banks in the Post-LCR period.

6.2 Changes in Liquid Liabilities for LCR and non-LCR Banks

We compare LCR and non-LCR banks across different LCR run-off categories. In particular, high run-off liabilities – such as, overnight debt, trading liabilties, commercial ppaer and short-term funding (Table 3) – are short maturity, volatile liabilities considered to have a high probability of being run on, per LCR. In unreported results, we find no significant differences between LCR and non-LCR banks across high, medium and low run-off categories, similar to the result for overall liabities. One reason for this result may be that the most liquid liabilities (e.g. deposits) are concentrated among the largest banks. Therefore, we make a further distinction between full LCR banks with assets more than \$250 billion who had to start implementing LCR by January 2015 and modified or mod-LCR banks with assets between \$50 billion and \$250 billion that needed to implement LCR by January 2016. For further identification, we split the Post-LCR period dummy into $2013-2015$, a dummy variable equal to is 1 for 2013 to 2015 Q1, and 2015+ which is a dummy variable that is 1 for the subsequent period. Given the delay in implementation, we expect the mod-LCR banks to adjust later.

Table 10 shows results of panel regressions of changes in total liabilities and those for high run-off categories. The first 2 columns show results for the liability side BBN and $LMIN$. Similar to our earlier result, there is no change $BBNL$ for either the full or mod-LCR banks relative to other banks. However, we find increased $LMINL$ for full LCR banks and increased or flat $LMINL$ for mod LCR banks post-2103.

The difference in the two measures reflect the different assignments of weights to liability items (Table 3). To get a better sense of the source of these changes, the remaining columns of Table 10 show changes in BV weights of total high run-off liabilities and individual items in this category. We find that full LCR banks have decreased BV weights while modified LCR banks have increased weights in the high run-off liabilities and this is true both for the early LCR and late LCR periods. In fact, the coefficients for the 2 periods are similar for both the full and mod-LCR banks. Considering individual high run-off liability items, we find that full LCR banks reduced their repo sold after 2013 Q2, and their use of commercial paper after 2015 Q1. Modified LCR banks increased their holdings of of short-term other borrowed money (OBM) in both LCR periods and of trading liabilities between 2013 and 2015 Q1. Overall, these results are consistent with the largest banks with assets exceeding $250 billion reducing their dependence on the most volatile liabilities. In contrast, other large banks that are also subject to LCR do not reduce their reliance on unstable liabilities. Anticipating the next result, the modified LCR banks adjust to LCR by substantially reducing their investment in illiquid assets.

Can we reconcile the difference in liquidity-weighted liabilities for BB and LMI? From Table 10, there may be 2 sources. Commercial paper, OBM$\leq$1 Year are considered high run-off by the LCR and assigned positive weights by LMI but zero weight by BB. From our results, there are substantial differences between full and mod-LCR banks in changes in BV weights in these categories. The second difference lies in the treatment of deposits. BB considers transactions and savings deposits to be liquid with weight of 1/2 (equivalent to 1 in LMI) but LMI assigns zero weight to these items and LCR considers them to be medium run-off.

7 Additional investigations

In this section, we check whether the distinction between full and mod-LCR banks is confined to the liability side (section 6.2), or whether there are also differences in the overall and asset side liquidity creation. In particular, is there later adjustment to LCR by mod-LCR banks as compared to full-LCR banks? The results are reported in Table 11. The first 2 columns show changes in BBN and $LMIN$. The results are consistent with later adjustment by mod-LCR banks. In particular, while mod and full-LCR banks reduce liquidity creation, the former do so to a greater extent in the post-2015 Q1 period while the opposite is true for full LCR banks. Moreover, mod-LCR banks reduce liquidity less than full LCR banks in the early period but more in the later period.

Next, we consider the asset side components of the measures. The asset-side adjustments mirror those for the full measure. For example, for $BBNA$, mod-LCR banks adjust later and adjust more than full-LCR banks in the later period than the early LCR period. Finally, we consider changes in HQLA under BB, LMI and LCR weights. For the LCR-weighted HQLA changes, we do not find significant differences between the mod and full-LCR banks within the early or late LCR time periods. Instead, we find both types of banks adjusting earlier than later. Under LMI weights, however, we again find faster adjustment by mod-LCR banks in the late versus early LCR periods, and compared to full-LCR banks, a bigger adjustment in the late period and a smaller adjustment in the early period. Since the weight differences are tiny for Level 1, these differences reflect the relatively higher LMI liquidity weights for levels 2a and 2b, as compared to LCR. In particular, the results suggest that mod-LCR banks reduced their relative holdings of levels 2a and 2b assets later than full-LCR banks. This result is intuitive since mod-LCR banks had an additional year to comply with LCR and so had no incentives to reduce their higher-yielding assets early.

8 Conclusion

In this paper, we examine liquidity creation by LCR and non-LCR banks using the liquidity measures Liquidity Mismatch Index (LMI) (Bai et al. (2018)), and BB (Berger and Bouwman (2009)). Both measures are defined as liquidity-weighted liabilities minus liquidity-weighted assets, with the liquidity weights either derived from market prices (as with LMI) or pre-specified (as with BB). We divide both measures by total assets (denoted LMIN and BBN) to compare liquidity creation across banks of different sizes. Since LCR may be expressed similarly, liquidity creation is defined as the summed product of book-value weights time the liquidity weight, where the latter reflects the liquidity preference of the regulator (for LCR), the market (for LMI) or the researcher (for BB). Since the measures differ on how they define liquid and illiquid balance sheet categories, we first define common balance sheet categories (e.g. HQLA or particular loan or liability items). Then, we identify the effect of LCR on book-value weights for this category. Finally, we apply the liquidity weights to estimate the effect of LCR on liquidity creation under alternative preferences.

We identify the LCR effects in several ways. The first uses the time of LCR implementation (since 2013) and cross-section effects (i.e. LCR applies only to bank holding companies with total assets greater than $50 billion). Second, we use specific LCR-constrained balance sheet categories — HQLA on the asset side and, on the liability side, items that are grouped by their "runnability." Third, within the HQLA portfolio, we take advantage of an asset pair that is economically similar (e.g. they have the same LMI liquidity weight) but are assigned different LCR weights. Finally, we exploit the differential implementation of LCR for so-called full LCR banks with assets greater than $250 billion (who had to start implementation by January 2015) and mod-LCR banks with assets between $50 billion and $250 billion (who had to start implementation by January 2016).

We find that, since 2013, there has been reduced (by $LMIN$) or flat (by BBN) liquidity creation by LCR banks compared to non-LCR banks. By comparison, large non-LCR banks (those with assets between $3 billion and $50 billion) and smaller banks increased liquidity creation since 2013. Indeed, since 2015 LCR banks have created less liquidity than non-LCR banks per unit of assets–a historic reversal in the role of liquidity transformation. The reduction in liquidity creation occurs mostly on the asset side of the balance sheet, in that there is greater holdings of liquid assets and lower holdings of illiquid assets by

LCR banks post-2013, as compared to non-LCR banks. On the liability side, changes in liquidity-weighted liabilities are similar for all bank size groups post-2013.

To further identify the asset-side LCR effects, we decompose the asset-side measures into its HQLA and non-HQLA components. Since HQLA is a purely LCR-defined asset category, trends in these components are likely driven directly by LCR effects. Consistent with this idea, we find that trends in book-value weights are driven by the HQLA portion of the balance sheet as they increase for LCR banks as compared to non-LCR banks since 2013. Across HQLA liquidity levels, we find greater book-value weight changes for Level 1 assets and least for Level 2B assets. This is consistent with expectations since the difference between LCR weights and LMI or BB weights are minimal for Level 1, so that banks have a greater incentive to satisfy HQLA by holding more Level 1 assets (see equation 9). By comparison, market and regulator liquidity weights differ most Level 2B assets, and book value weights increase least for LCR banks in this category. The LCR-weighted change in HQLA for LCR banks post-2013 is less than the LMI-weighted changes, reflecting the lower regulatory preferences for less liquid HQLA such as Level 2B assets.

Considering individual assets within each HQLA level, we find a greater preference for reserves within Level 1 assets. Since the different liquidity weights are essentially the same for Level 1 assets, this difference may reflect banks' preference for the greater safety and convenience of reserves as compared to US Treasuries and other Level 1 assets. Of particular interest is a shift in LCR bank portfolios post-LCR to GNMA MBS (a Level 1 asset) rather than GSE MBS (a Level 2A asset). These assets are economically similar with an identical LMI weight. This shift cannot be explained by relatively greater issuances of GNMA or relative price effects. Hence, the result is indicative of an LCR effect on bank portfolio choice.

Finally, we examine liquid liabilities and illiquid assets, the components of traditional bank liquidity creation. We find decreased holdings of loans by LCR banks relative to non-LCR banks post-2013, particularly commercial and residential real estate loans Considering liabilities, we find a decline in the high run-off category liabilities by LCR banks relative to non-LCR banks post-2013. These loans are short maturity and volatile, which makes them more runnable. However, this effect is confined to the largest LCR banks with greater than $250 billion in assets. Smaller LCR banks increase their holdings of liquid liabilities. Instead, the smaller LCR banks satisfy LCR by reducing their holdings of illiquid assets more substantially than the largest LCR banks, particularly after 2015 Q1.

Lower liquidity mismatch of LCR banks is arguably a desired consequence of liquidity regulations. Where, then, would liquidity creation come from? We find that non-LCR banks created more liquidity but not enough to offset the effects on LCR banks. Proponents of narrow banks (i.e. banks that hold assets with low interest rates and credit risk against demandable deposits) might argue that non-bank financial intermediaries are best positioned to create liquidity (Gorton and Pennacchi (1990) and Pennacchi (2016)). In their view, illiquid assets observed on contemporary bank balance sheets are evidence of moral hazard created by deposit insurance and too-big-to-fail debt guarantees. Since the LCR mandates liquid assets and liabilities (i.e. a narrow banking balance sheet), it mitigates the historical distortions created favor of illiquid assets by government internventions.

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Table 1: HQLA and Non-HQLA Portfolios: Eligible Assets and Liquidity Weights

The table shows assets that are eligible to be considered as High Quality Liquid Assets (HQLA) by the LCR rules in each of the three liquidity categories: Level 1, Level 2A and Level 2B. The non-HQLA assets are all other assets in Y9-C (listed in Table 2) that are HQLA-ineligible. The "Haircut" column shows the haircut imposed on assets in that liquidity category. The "Constraint" column shows the minimum or maximum proportion of total HQLA applicable to assets in that liquidity category. The LCR weight equals 1 minus the haircut. The LMI weights are the average of assets in the level (see Table 2. Abbreviations used are RW for Risk Weights; MBS for Mortgage-Backed Securities; and GSE for Government-sponsored Enterprise.

	Assets	Haircut	Constraint	LCR Weight	LMI Weight
Level 1	Excess Reserves Treasuries Government Agency Debt / MBS Foreign Debt (0% RW)	0%	>60% of HQLA	1	.972
Level 2A	GSE Debt GSE MBS Foreign Debt ((0,20]% RW)	15%	2A + 2B <40%	.85	.96
Level 2B	Investment Grade Non-financial corporates Russell 1000 equities Investment Grade Municipals	50%	<15% HQLA	.5	.792
Non-HQLA	All Other Corporate Bonds All Other MBS & Structured Products All Loans	100%	N/A	0	.475

Table 2: Asset-Side Liquidity Categories and Weights: BB, LMI and LCR

The table shows the asset-side liquidity categoires and weights for the Berger-Beouwman measure BB (Berger and Bouwman (2009)), the Liquidity Mismatch Index LMI (Bai et al. (2018)) and LCR. LMI weights are shown for January 2009, 2013, 2015 and December 2017.

<table>
<tr><th>Berger Bouwman
Category (& weight)</th><th>Balance Sheet Item (FR Y9C)</th><th>Bai et. al LMI
Category</th><th>LMI Weight
(Jan. 2013)</th><th>LCR
Weight</th></tr>
<tr><td rowspan="3">Illiquid Assets (weight = 1/2)</td><td>Other Real Estate owned,
Customers liab. on acceptances,
Inv. in subsidiaries, Premises</td><td>Fixed Assets</td><td rowspan="2">0</td><td rowspan="4">0</td></tr>
<tr><td>Intangible & Other</td><td>Intangible & Other</td></tr>
<tr><td>Loans:
Commercial & Industrial,
Commercial Real Estate,
Agricultural, Other, Lease Financing</td><td rowspan="2">Loans</td><td rowspan="2">.243</td></tr>
<tr><td>Semiliquid Assets (weight = 0)</td><td>Loans:
Residential Real Estate, Consumer,
To Depository Institutions,
To State & Local, To Foreign Govts.</td></tr>
<tr><td rowspan="9">Liquid Assets (weight = -1/2)</td><td>Cash/Balances due from Dep. Institutions
Fed Funds Sold</td><td>Cash</td><td>1</td><td rowspan="3">1</td></tr>
<tr><td>Treasury Securities</td><td rowspan="8">Securities
(Available for Sale,
Held to Maturity,
Trading)</td><td>.958</td></tr>
<tr><td>Government Agency Debt and MBS</td><td rowspan="2">.960</td></tr>
<tr><td>GSE Debt and MBS</td><td>.85</td></tr>
<tr><td>Municipal Securities</td><td>.770</td><td rowspan="3">.5</td></tr>
<tr><td>Equity Securities</td><td>.833</td></tr>
<tr><td>Other Domestic Debt (IG)</td><td rowspan="2">.774</td></tr>
<tr><td>Other Domestic Debt (HY)</td><td rowspan="2">0</td></tr>
<tr><td>Structured Products
(incl. non-agency MBS)</td><td>.712</td></tr>
</table>

Table 3: Liability-Side Liquidity Categories and Weights: BB, LMI and LCR

The table shows the liability-side liquidity categoires and weights for the Berger-Beouwman measure BB (Berger and Bouwman (2009)), the Liquidity Mismatch Index LMI (Bai et al. (2018)) and LCR. LMI weights are shown for January 2013.

<table>
<tr><th>Berger-Bouwman
Category</th><th>Balance Sheet Item (FR Y9C)</th><th>Bai et. al
LMI Category</th><th>LMI Weight
(Jan. 2013)</th><th>Authors'
LCR Outflows
Categorization</th></tr>
<tr><td rowspan="4">Liquid
Liabilities
(weight = 1/2)</td><td>Overnight Fed. Funds. Purchased</td><td>Overnight
Debt</td><td>1</td><td rowspan="2">High
Run-Off</td></tr>
<tr><td>Trading Liabilities</td><td>Trading Liabilities</td><td>.939</td></tr>
<tr><td>Transaction Deposits
Savings Deposits</td><td rowspan="2">Deposits</td><td rowspan="2">∼0</td><td rowspan="2">Medium
Run-Off</td></tr>
<tr><td rowspan="4">Time Deposits
Other Borrowed Money</td></tr>
<tr><td rowspan="3">Semi-Liquid
Liabilities
(weight = 0)</td><td>Commercial Paper</td><td>.884</td><td rowspan="2">High
Run-Off</td></tr>
<tr><td>Maturity <= 1 Year</td><td>.227</td></tr>
<tr><td>Maturity >= 1 Year</td><td>.001</td><td rowspan="3">Low Run-Off</td></tr>
<tr><td rowspan="2">Illiquid Liabilities
(weight = -1/2)</td><td rowspan="2">Subordinated Debt
Other Liabilities
Equity</td><td>Other Liabilities</td><td>∼0</td></tr>
<tr><td>Equity</td><td>∼0</td></tr>
</table>

Table 4: Liquidity Creation by LCR and non-LCR Banks: BBN and LMIN

The table shows results from a panel regression of the change in BBN and LMIN, the Berger-Beouwman measure (Berger and Bouwman (2009) and the Liquidity Mismatch Index (Bai et al. (2018)), respectively, divided by assets. The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q2 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. “Bankfe=Yes” indicates a bank fixed effect. The sample is 2009 Q1 to 2017 Q4.

	Δ BBN (On-Balance Sheet)			Δ LMIN		
Post-LCR	0.50***	0.63***	0.67***	0.71***	0.78***	0.84***
	(11.57)	(12.59)	(12.89)	(22.05)	(19.48)	(19.77)
Mid-Sized	0.03	0.21**		-0.06*	0.04	
	(0.68)	(2.43)		(-1.92)	(0.69)	
LCR Bank	-0.20***	0.12		-0.19***	0.02	
	(-3.54)	(1.19)		(-4.04)	(0.30)	
Post-LCR x Mid-Sized		-0.32***	-0.39***		-0.17**	-0.31***
		(-3.00)	(-4.45)		(-2.47)	(-4.81)
Post-LCR x LCR Bank		-0.61***	-0.70***		-0.40***	-0.49***
		(-5.46)	(-6.37)		(-4.20)	(-5.07)
Constant	-0.06*	-0.12***	-0.07***	-0.51***	-0.55***	-0.54***
	(-1.82)	(-3.31)	(-3.05)	(-18.97)	(-17.57)	(-31.29)
Observations	15462	15462	15462	15462	15462	15462
LCR		0.02			-0.14	
S.E.		[0.05]			[0.05]	
Total Effects:						
Mid-Sized		0.39			0.10	
S.E.		[0.03]			[0.03]	
Difference		-0.38			-0.24	
(T-stat)		(-6.17)			(-4.54)	
Bank F.E.	No	No	Yes	No	No	Yes

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Asset and Liability Side Liquidity Creation by LCR and non-LCR Banks: BBN and LMIN

The table shows results from a panel regression of the change in the assets and liabilities-side components of BBN and LMIN, the Berger-Beouwman measure (Berger and Bouwman (2009) and the Liquidity Mismatch Index (Bai et al. (2018)), respectively, divided by assets. The liquid, semi-liquid and illiquid asset categories are defined in Table 2. The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q4 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. "Bankfe=Yes" indicates a bank fixed effect. The sample is 2009 Q1 to 2017 Q4.

	Weighted Assets		BBN Asset Categories (Balance Sheet Value)			Weighted Liabilities		BBN Liabilitiy Categories (Balance Sheet Value)		
	BBN Assets	LMIN Assets	Liquid (-1/2)	Semi-Liquid (0)	Illiquid (1/2)	BBN Liabilities	LMIN Liabilities	Liquid (1/2)	Semi-Liquid (0)	Illiquid (-1/2)
Post-LCR	0.75***	0.72***	-0.86***	0.18***	0.65***	-0.13***	0.09***	-0.31***	0.62***	-0.05***
	(18.97)	(22.07)	(-19.45)	(7.83)	(16.69)	(-4.23)	(4.84)	(-5.21)	(15.87)	(-2.87)
Mid-Sized	0.15*	0.10*	-0.18**	0.05	0.11	0.07	-0.06*	0.07	0.10	-0.06**
	(1.89)	(1.75)	(-2.21)	(1.20)	(1.37)	(1.47)	(-1.80)	(0.84)	(1.62)	(-2.48)
LCR Bank	0.15*	-0.04	-0.22**	0.10	0.07	-0.03	0.07	-0.07	-0.06	-0.01
	(1.83)	(-0.49)	(-2.39)	(1.39)	(0.84)	(-0.47)	(1.35)	(-0.63)	(-0.55)	(-0.45)
Post-LCR x	-0.25***	-0.18***	0.33***	-0.12***	-0.18*	-0.07	0.02	-0.08	0.05	0.06**
Mid-Sized	(-2.79)	(-2.61)	(3.41)	(-2.74)	(-1.93)	(-1.22)	(0.61)	(-0.68)	(0.61)	(2.36)
Post-LCR x	-0.60***	-0.32***	0.73***	-0.23***	-0.46***	-0.01	-0.17	-0.09	0.38***	-0.08
LCR Bank	(-6.25)	(-3.04)	(6.10)	(-3.05)	(-4.94)	(-0.15)	(-1.58)	(-0.87)	(2.94)	(-1.49)
Constant	-0.36***	-0.46***	0.43***	-0.15***	-0.29***	0.24***	-0.08***	0.55***	-0.96***	0.08***
	(-11.80)	(-19.04)	(13.24)	(-8.30)	(-9.27)	(10.62)	(-4.72)	(12.72)	(-34.13)	(6.80)
Observations	15462	15462	15462	15462	15462	15462	15462	15462	15462	15462
Total Effects:										
LCR	-0.06	-0.10	0.08	-0.09	-0.03	0.07	-0.09	0.08	-0.01	-0.06
S.E.	[0.05]	[0.05]	[0.05]	[0.06]	[0.06]	[0.03]	[0.07]	[0.04]	[0.05]	[0.03]
Mid-Sized	0.29	0.18	-0.28	-0.03	0.30	0.10	-0.03	0.24	-0.19	0.03
S.E.	[0.03]	[0.02]	[0.03]	[0.02]	[0.03]	[0.02]	[0.01]	[0.05]	[0.03]	[0.02]
Difference	-0.34	-0.29	0.36	-0.06	-0.33	-0.03	-0.06	-0.16	0.18	-0.10
(T-stat)	(-5.70)	(-4.76)	(5.67)	(-0.81)	(-4.47)	(-0.88)	(-0.77)	(-2.45)	(3.00)	(-3.17)
Bank F.E.										

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Book Value and Liquidity-Weighted Changes in HQLA: LCR and non-LCR Banks

The table shows results from a panel regression of the change in the book-value weights and liquidity creation for HQL assets using liquidity weights from LCR, the Berger-Beouwman measure BB (Berger and Bouwman (2009) and the Liquidity Mismatch Index LMI (Bai et al. (2018)). The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q4 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. The sample is 2009 Q1 to 2017 Q4.

	Balance Sheet Value				Weighted Value		
	HQLA	Level 1 (1)	Level 2a (.85)	Level 2b (.5)	-BBN HQLA	-LMIN HQLA	LCR HQLA
Post-LCR	-0.83***	-0.37***	-0.32***	-0.15***	-0.42***	-0.79***	-0.56***
	(-17.68)	(-9.74)	(-7.97)	(-7.99)	(-17.68)	(-17.64)	(-10.34)
Mid-Sized	-0.21*	-0.03	-0.11	-0.06*	-0.11*	-0.19*	-0.07
	(-2.56)	(-0.59)	(-1.75)	(-2.27)	(-2.56)	(-2.48)	(-0.88)
LCR Bank	-0.26**	-0.00	-0.09	-0.16***	-0.13**	-0.23**	-0.12
	(-3.06)	(-0.08)	(-1.72)	(-4.51)	(-3.06)	(-2.99)	(-1.53)
Post-LCR x	0.34***	0.14	0.15	0.05	0.17***	0.32***	0.20
Mid-Sized	(3.60)	(1.91)	(1.88)	(1.60)	(3.60)	(3.55)	(1.91)
Post-LCR x	0.78***	0.32***	0.27***	0.19***	0.39***	0.72***	0.56***
LCR Bank	(7.45)	(3.44)	(3.71)	(5.36)	(7.45)	(7.32)	(5.28)
Constant	0.43***	0.19***	0.11***	0.12***	0.21***	0.41***	0.30***
	(12.58)	(7.36)	(4.15)	(8.85)	(12.58)	(12.87)	(8.40)
Observations	15462	15462	15462	15462	15462	15462	15462
Total Effects:							
LCR	0.11	0.13	-0.02	0.00	0.05	0.11	0.18
S.E.	[0.05]	[0.04]	[0.04]	[0.01]	[0.02]	[0.05]	[0.05]
Mid-Sized	-0.27	-0.07	-0.17	-0.03	-0.14	-0.25	-0.13
S.E.	[0.03]	[0.03]	[0.02]	[0.01]	[0.01]	[0.03]	[0.04]
Difference							
(T-stat)	(6.87)	(3.99)	(3.20)	(2.22)	(6.87)	(6.70)	(4.70)
Bank F.E.							

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Book Value Changes of Individual HQL Assets: LCR and non-LCR Banks

The table shows results from a panel regression of the change in the book-value weights for individual HQL assets. The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q4 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. The sample is 2009 Q1 to 2017 Q4.

	Δ Level 1				Δ Level 2A		Δ Level 2B	
	Reserves	Treasuries	Agency Debt	GNMA MBS	GSE MBS	GSE Debt	Equities	Muni
Post-LCR	-0.27***	-0.013	-0.011	-0.071***	0.0026	-0.12***	0.0041	-0.15***
	(-7.96)	(-0.98)	(-1.40)	(-4.67)	(0.10)	(-4.51)	(0.78)	(-8.60)
Mid-Sized	0.0011	-0.00039	-0.0094	-0.026	-0.066	-0.027	-0.0077	-0.058**
	(0.02)	(-0.02)	(-1.41)	(-1.62)	(-1.62)	(-0.85)	(-0.99)	(-2.15)
LCR Bank	-0.077	0.075*	-0.022***	0.019	0.038	-0.054**	-0.028	-0.14***
	(-1.58)	(1.82)	(-3.64)	(0.97)	(1.04)	(-2.23)	(-0.99)	(-8.36)
Post-LCR x Mid-Sized	0.078	0.018	0.0066	0.039*	0.077	0.044	0.0057	0.048
	(1.17)	(0.74)	(0.62)	(1.72)	(1.59)	(0.95)	(0.68)	(1.46)
Post-LCR x LCR Bank	0.23***	-0.010	0.015*	0.084**	-0.016	0.11***	0.024	0.16***
	(3.19)	(-0.20)	(1.68)	(2.40)	(-0.26)	(3.18)	(0.88)	(7.79)
Constant	0.12***	0.012	0.026***	0.033***	-0.056***	0.018	-0.0064	0.13***
	(5.46)	(1.29)	(5.13)	(3.25)	(-2.84)	(1.06)	(-1.47)	(9.84)
Observations	15462	15462	15462	15462	15462	15462	15462	15462

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Book Value Changes of GNMA and GSE MBS: LCR and non-LCR Banks

The table shows results from a panel regression of the change in the book-value weights for GNMA and GSE MBS. *GNMA-GSE Spread* is the GNMA MBS issuance rate minus the GSE MBS issuance rate. *GNMA Issuance share* is the share of GNMA MBS issuances in total GSE plus GNMA MBS issuances. The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q4 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. The sample is 2009 Q1 to 2017 Q4.

	Δ GNMA MBS				Δ GSE MBS			
Post-LCR	-0.07***	-0.07***	-0.07***	-0.07***	0.00	0.01	0.02	0.00
	(-4.67)	(-4.64)	(-4.63)	(-4.58)	(0.14)	(0.53)	(0.62)	(0.03)
Mid-Sized	-0.03	-0.03	-0.03		-0.07	-0.07	-0.07	
	(-1.62)	(-1.62)	(-1.62)		(-1.61)	(-1.64)	(-1.62)	
LCR Bank	0.02	0.02	0.02		0.04	0.04	0.04	
	(0.97)	(0.97)	(0.97)		(1.04)	(1.03)	(1.03)	
Post-LCR x Mid-Sized	0.04*	0.04*	0.04*	0.03	0.08	0.08*	0.08*	0.07
	(1.72)	(1.69)	(1.69)	(1.56)	(1.60)	(1.69)	(1.67)	(1.63)
Post-LCR x LCR Bank	0.08**	0.09**	0.09**	0.09**	-0.02	-0.01	-0.01	-0.01
	(2.40)	(2.22)	(2.22)	(2.48)	(-0.26)	(-0.21)	(-0.22)	(-0.17)
GNMA-GSE MBS Spread Control	-0.05		-0.06		-0.59***		-0.73***	
	(-0.69)		(-0.65)		(-4.24)		(-5.10)	
GNMA MBS Issuance Share Control		0.02	-0.01			-1.18***	-1.46***	
		(0.10)	(-0.03)			(-4.31)	(-5.26)	
Constant	0.03***	0.03***	0.03***	0.03***	-0.06***	-0.06***	-0.06***	-0.07***
	(3.24)	(3.26)	(3.25)	(4.50)	(-2.96)	(-2.92)	(-3.10)	(-6.02)
Observations	15462	14589	14589	15462	15462	14589	14589	15462
bankfe				Yes				Yes

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Book Value Changes of Semi-Liquid and Illiquid Loans: LCR and non-LCR Banks

The table shows results from a panel regression of the change in the book-value weights for semi-liquid and illiquid loans; the definitions of the loan categories are in Table 3. The Post-LCR dummy is 1 from 2013 Q2 to 2017 Q4 and zero otherwise. LCR Bank is a dummy variable equal to 1 for banks that were required to implement the LCR rule. The sample is 2009 Q1 to 2017 Q4.

	Δ Illiquid Loans Weight = 1/2				Δ Semi-Liquid Loans Weight = 0			
	Comm. Industrial	Comm. Real Estate	Agricultural	Lease Financing	Res. Real Estate	Consumer	Dep. Inst.	Foreign Govt.
Post-LCR	0.15***	0.49***	0.019***	0.014	0.11***	0.080***	-0.00088	-0.0000035
	(7.84)	(15.61)	(3.60)	(1.44)	(5.02)	(6.93)	(-0.45)	(-0.99)
Mid-Sized	0.056	-0.013	0.0040	0.0086	0.040	0.0051	0.0012	0.00039
	(1.40)	(-0.23)	(0.66)	(0.99)	(1.21)	(0.23)	(0.25)	(1.51)
LCR Bank	0.086	-0.018	0.0050	-0.012	0.036	0.050	0.012**	0.00094*
	(1.41)	(-0.33)	(1.29)	(-0.76)	(0.89)	(0.94)	(2.24)	(1.75)
Post-LCR x Mid-Sized	-0.095**	-0.060	-0.017**	-0.0043	-0.10***	-0.015	-0.0040	-0.00061
	(-2.11)	(-0.96)	(-2.32)	(-0.36)	(-2.75)	(-0.68)	(-0.59)	(-1.50)
Post-LCR x LCR Bank	-0.10	-0.25***	-0.018***	-0.016	-0.19***	-0.0076	-0.023**	-0.00062
	(-1.57)	(-4.23)	(-3.32)	(-1.20)	(-3.32)	(-0.14)	(-2.56)	(-1.43)
Constant	-0.064***	-0.21***	-0.0059	-0.013*	-0.088***	-0.058***	0.0014	0.0000035
	(-4.39)	(-8.21)	(-1.56)	(-1.87)	(-5.72)	(-6.59)	(0.87)	(0.99)
Observations	15462	15462	15462	15462	15462	15462	15462	15462

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Changes in Liquid Liabilities of Early and Late-Adopting LCR Banks and non-LCR Banks

The table shows results from a panel regression of the change in total liabilities and those liabilities regarded as high run-off by LCR. The first two columns show changes in $BBNL$ and $LMINL$. The remaining columns show changes in the book-value weights. The 2013-2015 dummy is 1 from 2013 Q2 to 2015 Q1 and zero otherwise. The 2015+ dummy is 1 from 2015 Q2 to 2017 Q4 and zero otherwise. Full-LCR Bank is a dummy variable equal to 1 for banks with assets greater than $250 billion that were required to start implementing LCR by 2015Q1. Mod-LCR Bank is a dummy variable equal to 1 for banks with assets between $50 billion and $250 billion that required to start implementing LCR by 2016Q1. The sample is 2009 Q1 to 2017 Q4.

	Δ Overall Weighted	Δ Outflow Category	Δ High Run-Off Liability Categories				
	LMIN Liabilities	High Run-Off	Repo Sold	FedFunds Purchased	Trading	Com. Paper	OBM < 1 year
2013-2015	0.079***	0.20***	0.022*	0.031*	0.00057	-0.0048	0.15***
	(4.02)	(7.08)	(1.88)	(1.84)	(0.51)	(-1.20)	(6.77)
2015+	0.068***	0.17***	-0.0075	0.038*	0.0012	-0.00023	0.14***
	(2.85)	(5.60)	(-0.87)	(1.77)	(1.25)	(-0.12)	(7.15)
Mid-Sized	-0.079**	-0.11***	-0.077**	0.0049	-0.0020	-0.0027	-0.031
	(-2.22)	(-2.60)	(-2.56)	(0.24)	(-0.66)	(-0.99)	(-1.15)
Mod-LCR	-0.069	-0.37***	-0.0021	-0.027	-0.017**	-0.0098	-0.31***
	(-1.63)	(-3.67)	(-0.21)	(-0.69)	(-2.23)	(-1.40)	(-3.19)
Full-LCR	0.28***	0.076	0.19**	0.025	-0.033	0.018	-0.12**
	(2.83)	(0.69)	(2.01)	(1.31)	(-1.45)	(0.70)	(-2.09)
Mid-Sized x 2013-2015	0.072**	0.14**	0.042	-0.011	0.0029	0.0074*	0.099**
	(1.99)	(2.48)	(1.36)	(-0.48)	(0.67)	(1.65)	(1.96)
Mid-Sized x 2015+	0.041	0.096*	0.043	-0.012	-0.00072	0.0027	0.063
	(1.08)	(1.87)	(1.52)	(-0.49)	(-0.29)	(0.99)	(1.59)
Mod-LCR x 2013-2015	0.15**	0.37**	0.019	0.053	0.037	0.025**	0.24*
	(2.06)	(2.56)	(0.82)	(0.95)	(1.56)	(2.00)	(1.89)
Mod-LCR x 2015+	0.16	0.46***	0.080	0.040	-0.0055	-0.00031	0.34***
	(1.47)	(2.98)	(0.88)	(0.85)	(-0.25)	(-0.02)	(3.52)
Full-LCR x 2013-2015	-0.57***	-0.45**	-0.47***	-0.022	0.069	-0.017	-0.013
	(-2.63)	(-2.10)	(-2.74)	(-1.24)	(1.16)	(-0.44)	(-0.17)
Full-LCR x 2015+	-0.35***	-0.28**	-0.17*	-0.028	-0.049	-0.092*	0.062
	(-3.56)	(-2.07)	(-1.96)	(-1.26)	(-1.43)	(-1.86)	(0.73)
Constant	-0.072***	-0.15***	-0.034***	-0.036**	-0.00095	0.00032	-0.075***
	(-3.77)	(-6.73)	(-4.97)	(-2.01)	(-1.03)	(0.18)	(-6.52)
Observations	15610	15610	15610	15610	15610	15608	15610

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Liquidity Creation by Early and Late-Adopting LCR Banks and non-LCR Banks

The table shows results from a panel regression of the change in BBN and $LMIN$ liquidity measures. Also shown are the asset side component of the measures. Finally, we show the liquidity-weighted assets for the BB category of liquid assets and HQLA. The 2015+ dummy is 1 from 2015 Q2 to 2017 Q4 and zero otherwise. Full-LCR Bank is a dummy variable equal to 1 for banks with assets greater than $250 billion that were required to start implementing LCR by 2015Q1. Mod-LCR Bank is a dummy variable equal to 1 for banks with assets between $50 billion and $250 billion that required to start implementing LCR by 2016Q1. The sample is 2009 Q1 to 2017 Q4.

	Overall Measures		Weighted Assets	Asset Category	HQLA		
	Δ BBN	Δ LMIN	BBN Assets	Liquid (-1/2)	-BBN HQLA	-LMIN HQLA	LCR HQLA
2013-2015	0.63***	0.77***	0.73***	-0.86***	-0.42***	-0.80***	-0.54***
	(10.37)	(17.20)	(14.91)	(-16.02)	(-14.84)	(-14.72)	(-7.49)
2015+	0.62***	0.79***	0.77***	-0.86***	-0.41***	-0.79***	-0.58***
	(11.10)	(17.31)	(17.20)	(-17.22)	(-15.58)	(-15.60)	(-9.89)
Mid-Sized	0.21**	0.04	0.15*	-0.18**	-0.11**	-0.19**	-0.07
	(2.43)	(0.69)	(1.89)	(-2.21)	(-2.56)	(-2.47)	(-0.88)
Mod-LCR	0.15	0.11	0.13	-0.24**	-0.14***	-0.25***	-0.16**
	(1.11)	(1.05)	(1.24)	(-2.16)	(-2.69)	(-2.65)	(-1.96)
Full-LCR	0.07	-0.12	0.18	-0.19	-0.11*	-0.21	-0.04
	(0.56)	(-0.96)	(1.58)	(-1.24)	(-1.67)	(-1.62)	(-0.30)
Mid-Sized x 2013-2015	-0.29**	-0.14*	-0.26**	0.33***	0.15***	0.27***	0.17
	(-2.33)	(-1.65)	(-2.56)	(3.02)	(2.72)	(2.58)	(1.18)
Mid-Sized x 2015+	-0.34***	-0.20***	-0.26***	0.33***	0.18***	0.35***	0.23**
	(-2.95)	(-2.63)	(-2.65)	(3.24)	(3.66)	(3.68)	(2.19)
Mod-LCR x 2013-2015	-0.57***	-0.44***	-0.55***	0.80***	0.44***	0.82***	0.79***
	(-2.82)	(-2.58)	(-3.16)	(3.82)	(4.61)	(4.39)	(4.14)
Mod-LCR x 2015+	-0.72***	-0.43***	-0.68***	0.74***	0.35***	0.65***	0.41***
	(-5.95)	(-4.12)	(-5.75)	(6.60)	(6.30)	(6.41)	(3.46)
Full-LCR x 2013-2015	-0.68***	-0.44**	-0.63***	0.89***	0.52***	1.00***	0.81***
	(-3.34)	(-2.22)	(-3.40)	(3.58)	(4.81)	(4.75)	(3.43)
Full-LCR x 2015+	-0.40**	-0.25*	-0.50***	0.52**	0.28***	0.53***	0.38*
	(-2.52)	(-1.67)	(-3.39)	(2.32)	(2.85)	(2.73)	(1.71)
Constant	-0.12***	-0.55***	-0.36***	0.43***	0.21***	0.41***	0.30***
	(-3.31)	(-17.57)	(-11.80)	(13.24)	(12.58)	(12.87)	(8.40)
Observations	15462	15462	15462	15462	15462	15462	15462

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Timeline of LCR Rule Proposal, Finalization and Implementation

The figure shows the timeline of the proposal, finalization and implementation of the LCR rule. Requirements for the largest banks were largely understood with the Basel III LCR Finalization (January 2013), while Modified LCR requirements specific to firms with assets between 50 billion and 250 billion were made clear with the U.S. rule finalization in late 2014.

Dec. 2010	Jan. 2013	Oct. 2013	Sep. 2014
Basel III proposal	Basel III Revised	U.S. rule proposed	U.S. rule finalized

Large US BHCs have accelerated schedule of implementation compared to the Basel III, with the first compliance date being January 2015 compared to January 2016 for Modified LCR banks.

Jan. 2015	Jan. 2016	Jan. 2017	Apr. 1, 2017
80% LCR	90% LCR	100% LCR	Disclosure for BHC $\geq$ \$700 bln CA
(Full Only)			

Figure 2: Liquidity Creation by LCR and non-LCR Banks: BB and LMI Measures

The figures show liquidity creation by size group for consolidated bank holding companies. The top panel shows the Berger-Bouwman catnonfat measure and the bottom panel plots the LMI measures, divided by assets (denoted BBN and $LMIN$, respectively). LCR banks have assets greater than \$50 billion and are required to implement the LCR rule. Mid-sized non-LCR banks have assets between \$3 billion and \$50 billion and are not subject to the LCR rule. Small banks have assets less than \$3 billion and are also not subject to the LCR rule. The sample is 2002 Q2 to 2016 Q4.

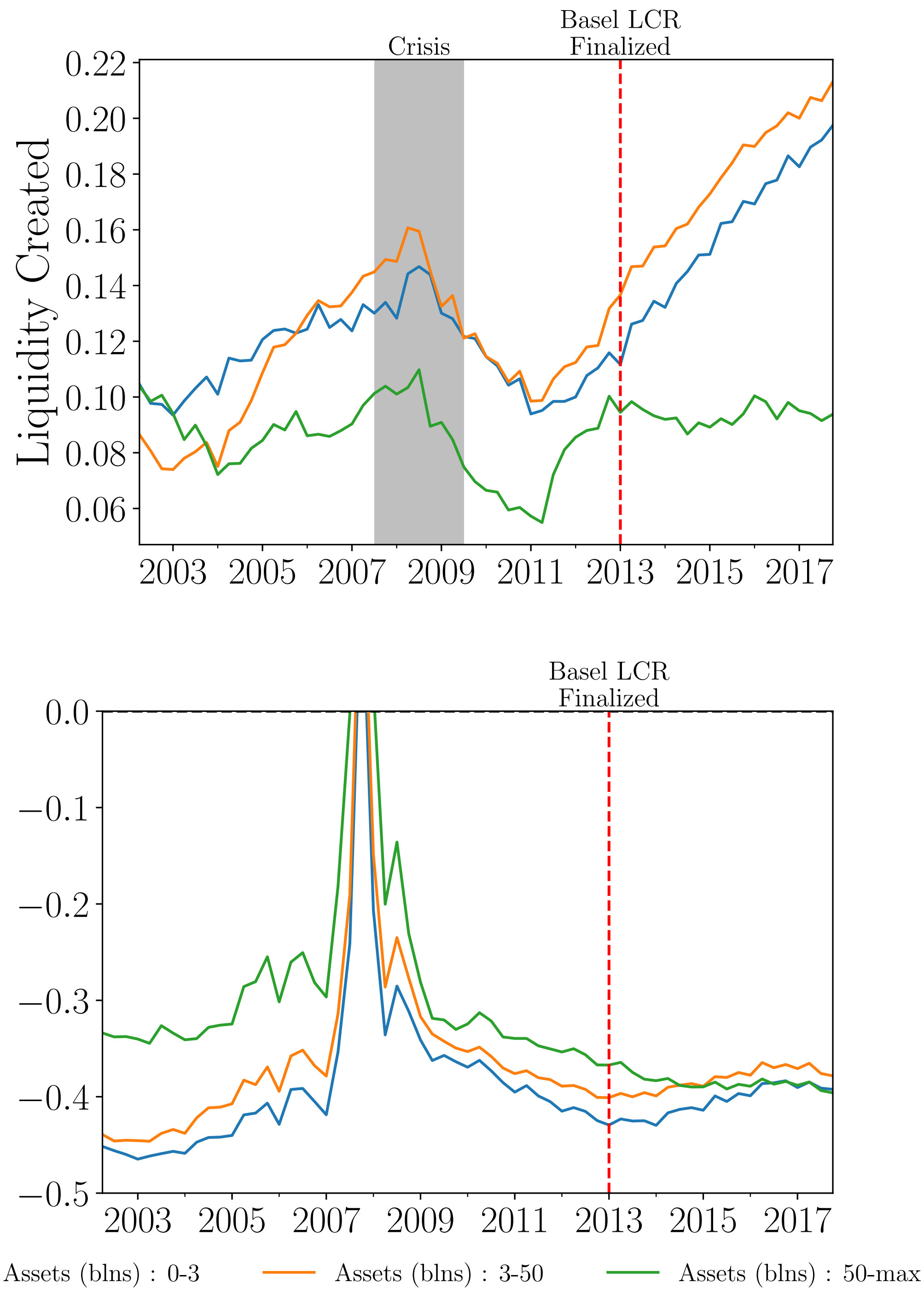


Figure 3: Asset and Liability Side Liquidity Creation of LCR and non-LCR Banks

The figures show asset and liabilities side liquidity creation by size group for consolidated bank holding companies. The top panesl shows the assets and liabilities components of the Berger-Bouwman catnonfat, divided by assets (denoted $BBAN$ and $BBLN$, respectively). The bottom panel plots -LMINA which are the liquidity-weighted assets, divided by assets, and LMINL, the liquidity-weighted liabilities, divided by liabilities. LCR banks have assets greater than \$50 billion and are required to implement the LCR rule. Mid-sized non-LCR banks have assets between \$3 billion and \$50 billion and are not subject to the LCR rule. Small banks have assets less than \$3 billion and are also not subject to the LCR rule. The sample is 2002 Q2 to 2017 Q4.

(a) BBN Assets

(b) BBN Liabilities

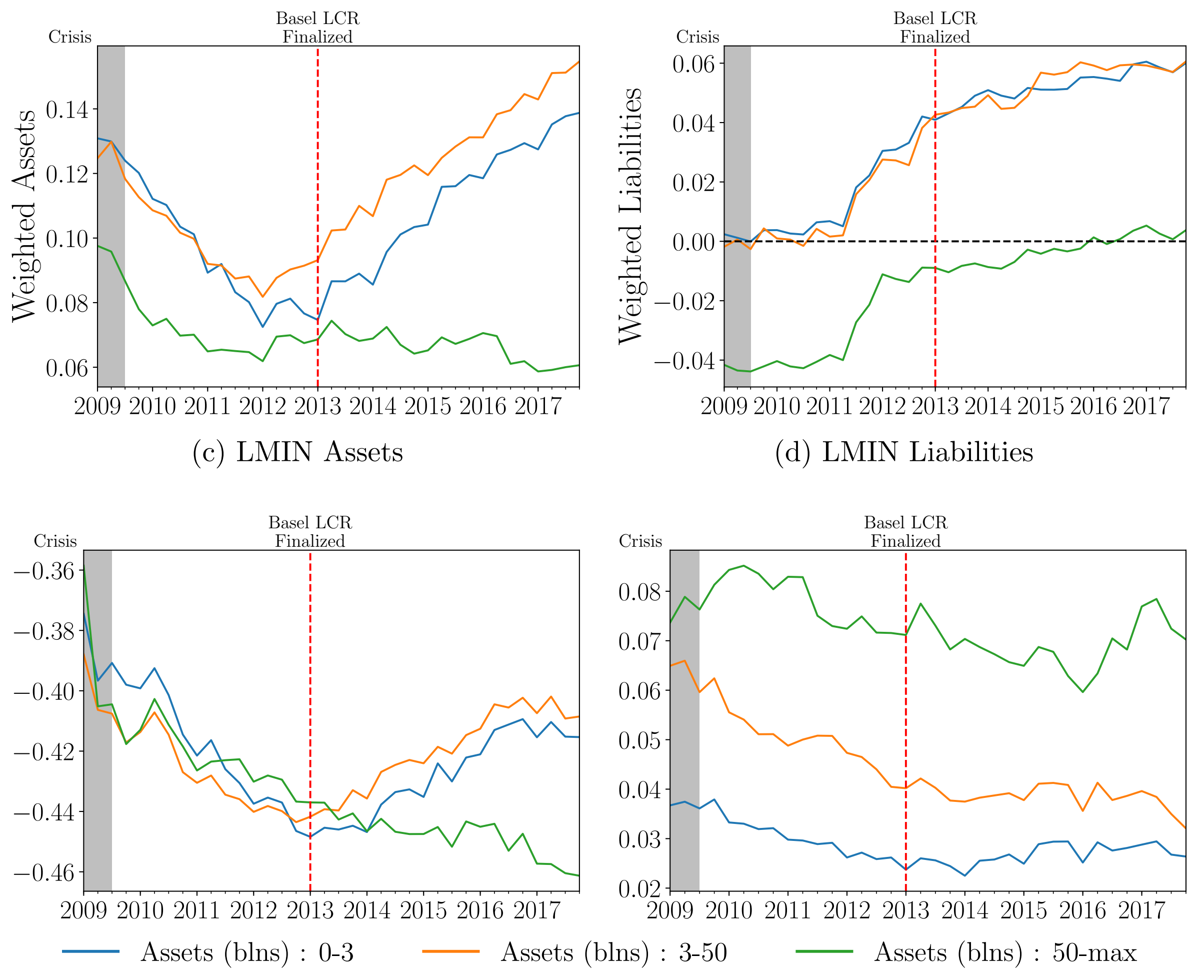
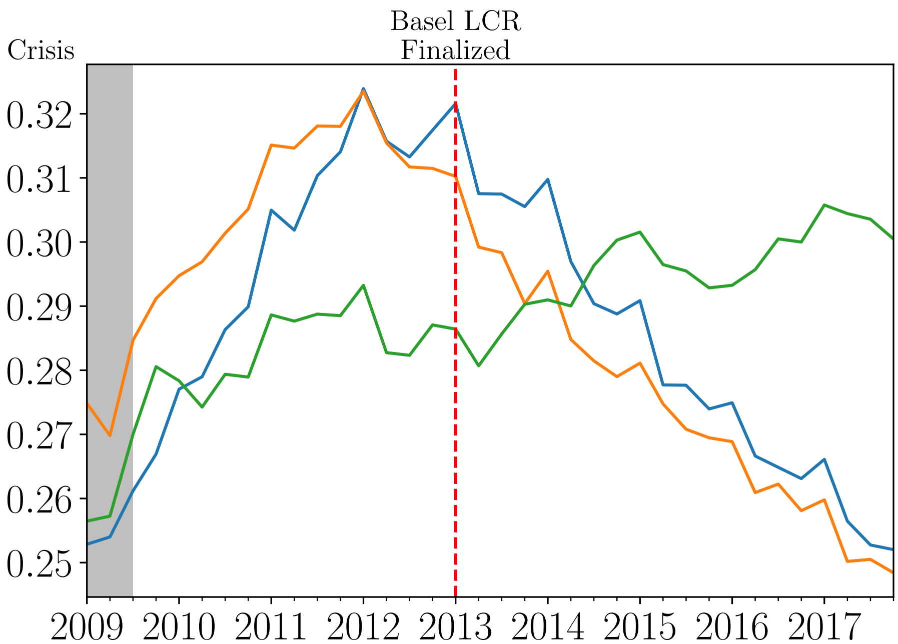


Figure 4: Changes in Liquid and Illiquid Assets by Bank Size Group: BB Measure

The figures show the Berger-Bouwman measure BB for liquid and illiquid asset categories (defined in Table 2) by size groups for consolidated bank holding companies. LCR banks have assets greater than \$50 billion and are required to implement the LCR rule. Large Non-LCR banks have assets between \$3 billion and \$50 billion and are not subject to the LCR rule. Small banks have assets less than \$3 billion and are also not subject to the LCR rule. The sample is 2002 Q2 to 2016 Q4.

(a) Liquid Assets



(b) Illiquid Assets

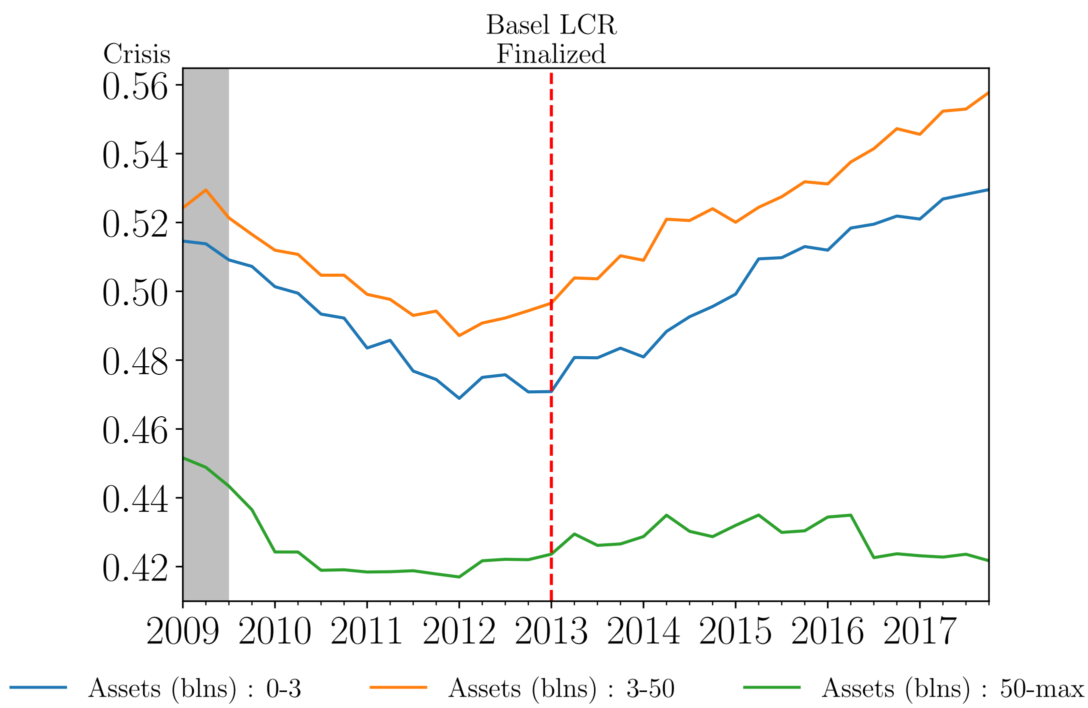


Figure 5: Changes in Book Value Weights of HQLA Levels: LCR and non-LCR Banks

The figures show changes in book value assets by size group for consolidated bank holding companies. The top panel shows book value changes in HQLA and Level 1 assets. The bottom panel shows book value changes in Level 2a and Level 2b assets. LCR banks have assets greater than $50 billion and are required to implement the LCR rule. Mid-sized non-LCR banks have assets between $3 billion and $50 billion and are not subject to the LCR rule. Small banks have assets less than $3 billion and are also not subject to the LCR rule. The sample is 2002 Q2 to 2017 Q4.

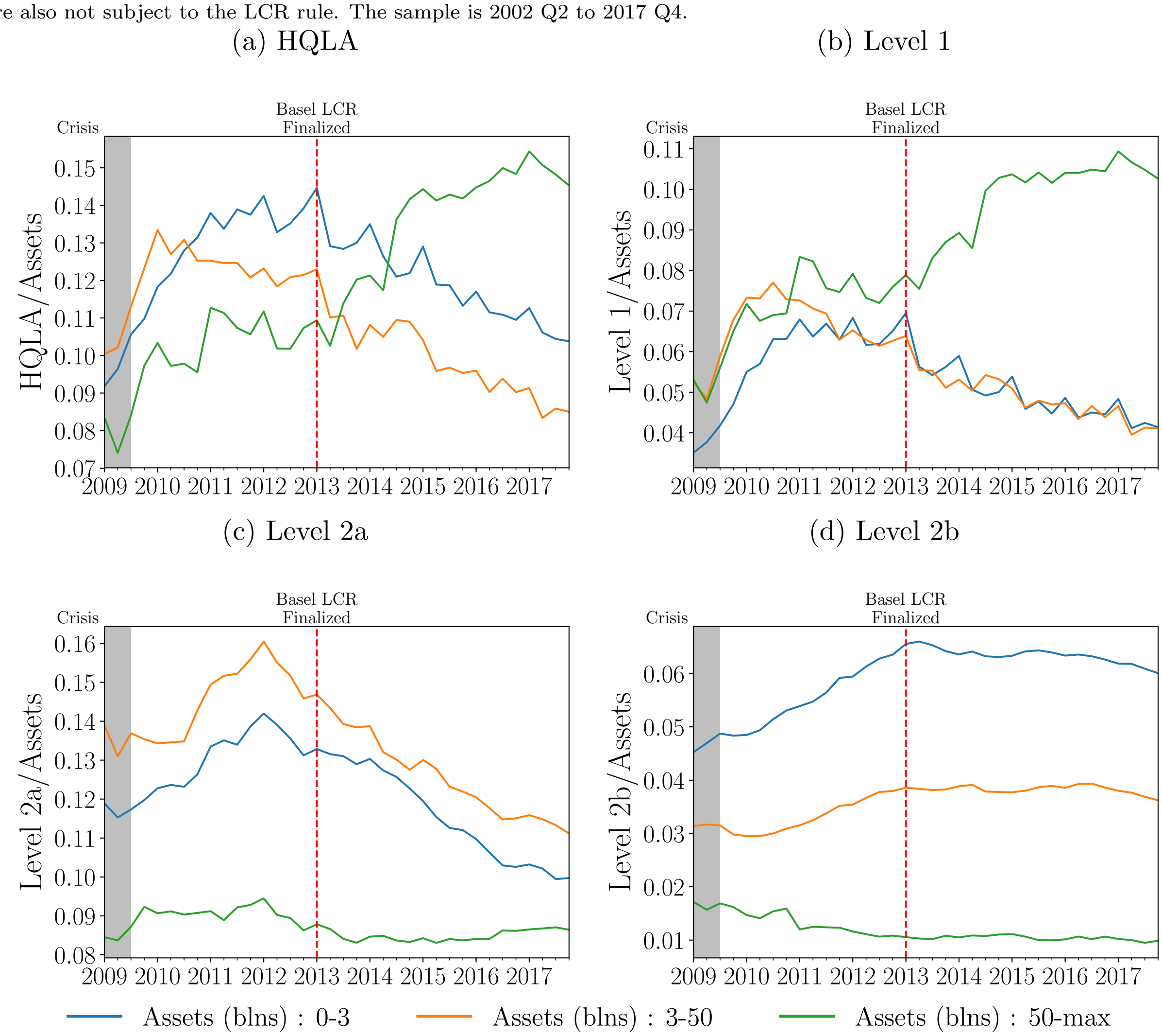
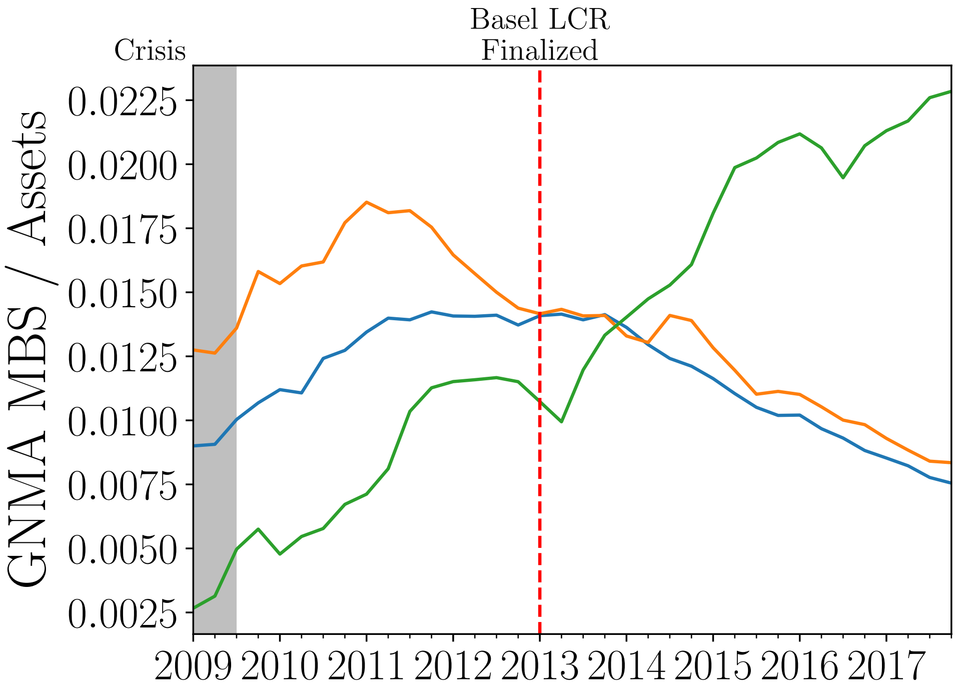


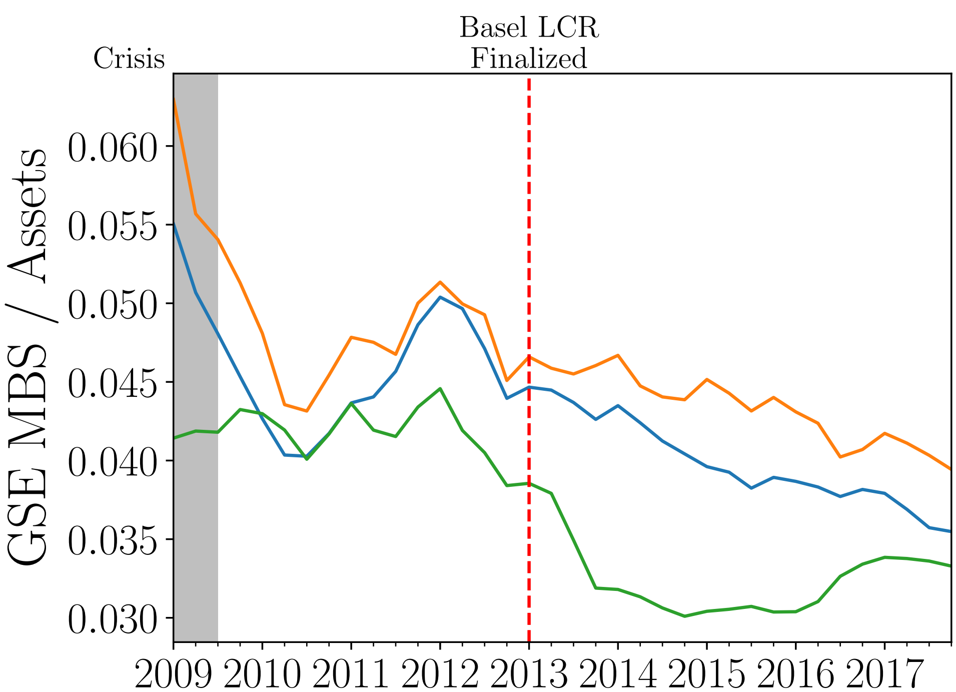
Figure 6: Changes in GNMA MBS vs GSE MBS

The figure shows the changes in GNMA and GSE MBS.

(a) GNMA MBS



(b) GSE MBS



Assets (blns) : 0-3 Assets (blns) : 3-50 Assets (blns) : 50-max

Figure 7: Changes in Loan Categories of LCR and non-LCR Banks

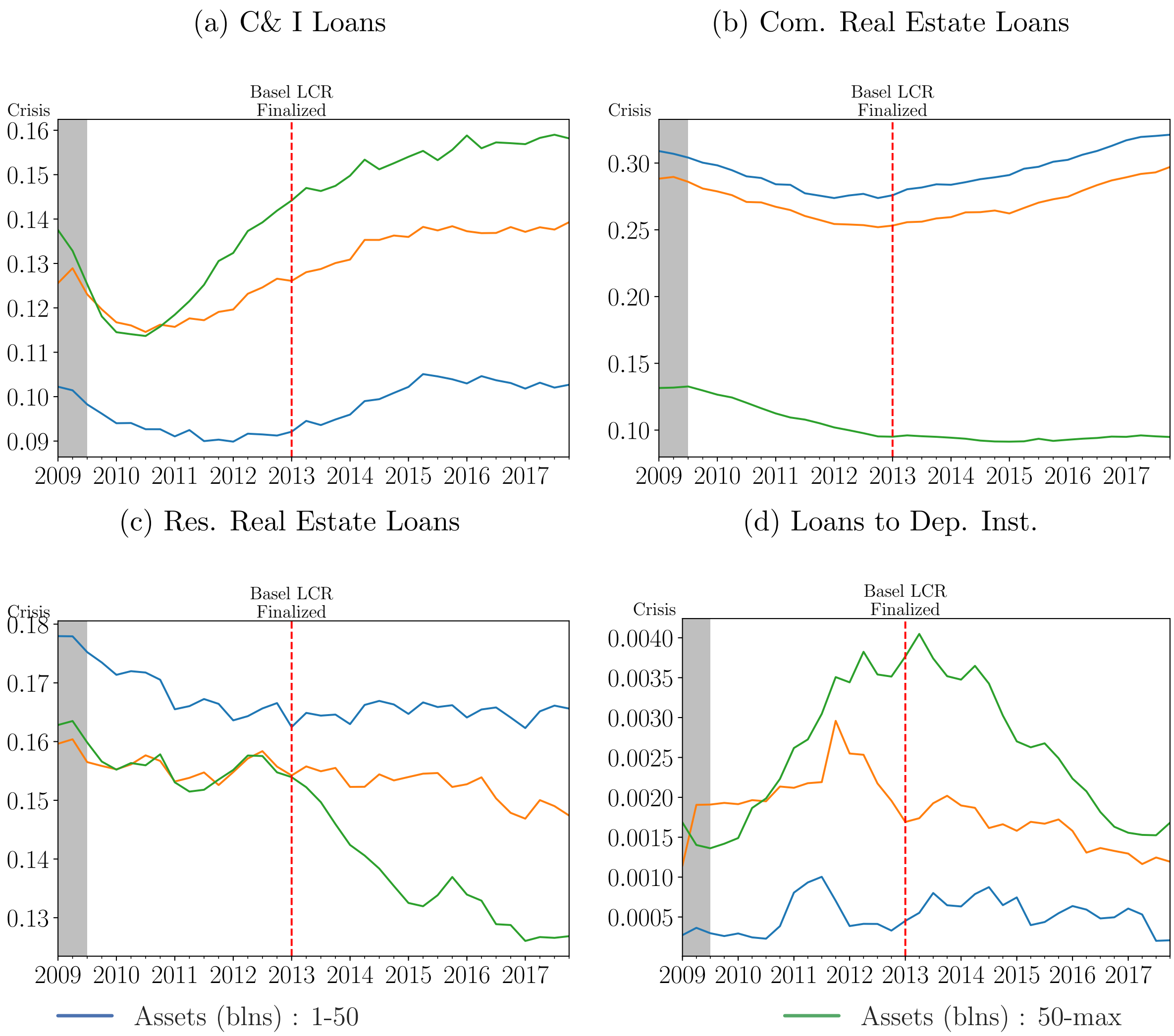
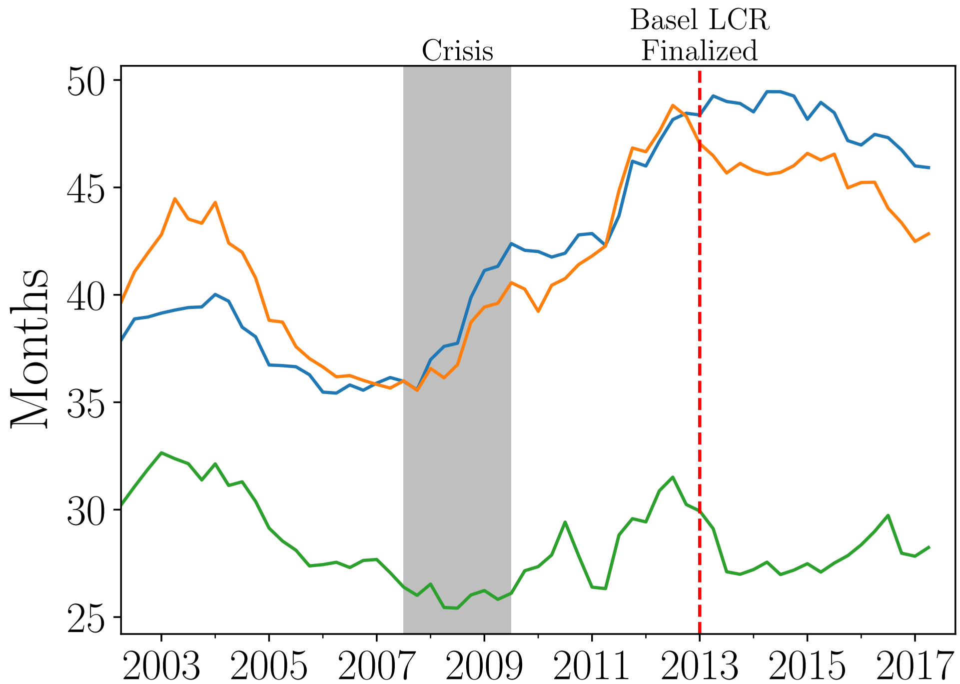


Figure 8: Duration of LCR and non-LCR Bank Assets

The figures shows the duration of total assets (denoted "Overall Duration") and the duration of debt securities of banks. LCR banks have assets greater than $50 billion and are required to implement the LCR rule. Large Non-LCR banks have assets between $3 billion and $50 billion and are not subject to the LCR rule. Small banks have assets less than $3 billion and are also not subject to the LCR rule. The sample is 2002 Q2 to 2017 Q2.

(a) Overall Duration



(b) Debt Securities Duration