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The Last Taxi: LCR Buffers and Bank Liquidity Provision[*]

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Abstract

This paper examines whether regulatory liquidity buffers enable banks to support corporate borrowers during financial stress. Using confidential bank-firm credit data and hand-collected Liquidity Coverage Ratio regulation (LCR) disclosures during COVID-19, we find that banks with higher LCR buffers above the regulatory minimum provided significantly more credit to firms with large undrawn credit lines in March 2020. Critically, only buffers, not overall LCR levels, matter, revealing that the regulatory minimum operates as a binding constraint during stress. The effect is concentrated among high-quality borrowers with clean credit profiles and disappears by mid-2020, confirming that LCR buffers provide selective, temporary liquidity insurance during acute stress.

JEL Classification: G01,G21,G28

Keywords: Liquidity regulation, Credit lines, Bank lending, Financial crises, Regulatory buffers

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1 Introduction

How do banks allocate their excess liquidity during times of stress when they are subject to minimum liquidity requirements? The answer to this question has been often linked to the “last taxi problem", a metaphor variously ascribed to a number of economists over the years, including Milton Friedman, and illustrated by Charles Goodhart as follows:[1] “The weary traveler who arrives at the railway station late at night, and, to his delight, sees a taxi there that could take him to his distant destination. He hails the taxi, but the taxi driver replies that he cannot take him, since local bylaws require that there must always be one taxi standing ready at the station.” This parable captures a fundamental tension in liquidity regulation: buffers designed to be used during stress may become frozen precisely when they are needed most.

The Liquidity Coverage Ratio (LCR), introduced as part of the Basel III reforms, requires large banks to hold sufficient high-quality liquid assets (HQLA) to cover projected net cash outflows over a 30-day stress period. The regulatory intent has been to mitigate the adverse effects of disruptive runs when banks are deemed to be solvent but illiquid (Diamond and Dybvig, 1983; Kashyap, Tsomocos, and Vardoulakis, 2024). Nevertheless, excess liquidity buffers have also been thought to enhance banks’ ability to provide credit during financial stress without resorting to fire sales of other assets or central bank borrowing. Yet, banks face strong disincentives to actually draw down their LCR buffers during stress. Using them may bring them closer to binding liquidity requirements and may signal weakness to markets. This creates a potential “last taxi” problem: the liquidity is there, visible on balance sheets, but effectively unavailable to support lending when firms need it most.

The distinction between a high LCR level and a high LCR buffer is critical. A bank with an LCR of 120% that faces a regulatory minimum of 100% has a 20 percentage point buffer, providing room to absorb stress without falling below the requirement. A bank with an LCR of 105% has only a 5 percentage point buffer, despite exceeding the regulatory threshold. If banks treat the 100% minimum as a hard floor they cannot breach (the “last taxi” constraint), then only banks with substantial buffers above this floor can provide meaningful liquidity insurance during stress. Banks with high LCR levels but minimal buffers would behave like Goodhart’s taxi driver, possessing the capacity but unable to deploy it due to regulatory constraints.

[1] Goodhart (2008). Liquidity risk management. *Banque de France Financial Stability Review*, 11, 39-44.

This paper uses confidential bank-firm credit data and hand-collected LCR disclosures to test whether LCR buffers, not just LCR levels, determine banks' ability to support corporate borrowers during the COVID-19 crisis in March 2020. During the acute phase of the crisis, firms drew heavily on credit lines as a precautionary liquidity buffer (Acharya and Steffen, 2020; Li, Strahan, and Zhang, 2020), creating a natural experiment to test whether regulatory liquidity buffers translate into actual credit supply during stress.

Our key contribution is to show that bank-level heterogeneity in liquidity positions shapes the allocation of credit line utilization within firms. Exploiting within-firm variation across lenders, we find that utilization increases disproportionately toward banks with higher pre-shock LCR buffers, even after controlling for firm-quarter demand and time-invariant relationship characteristics. This pattern reveals a supply-driven reallocation: banks with stronger buffers are better able—or more willing—to accommodate drawdowns on committed lines, while banks closer to the regulatory minimum tighten along non-price margins. We further show that liquidity buffers over regulatory minimums matter over and above the absolute liquidity levels. This result provides direct evidence that the LCR regulation operates as a binding constraint during stress (the "last taxi" problem). More broadly, our results highlight that liquidity insurance is not uniform across lenders but depends on intermediary constraints, implying that shocks transmit not only through the extensive margin of credit but also through the allocation of utilization across existing bank relationships.

Zooming into the details, our findings reveal three patterns that sharpen the "last taxi" interpretation. First, a horse race specification that simultaneously includes both LCR levels and buffers over LCR requirements shows that only buffers matter: banks with higher buffers above the regulatory minimum provided significantly more credit during the crisis, while banks with higher overall LCR levels but smaller buffers did not. Second, the effect is concentrated in the acute stress period: high-buffer banks provided 10.5% more credit to exposed firms in March 2020 but this differential disappears entirely by April-June 2020, confirming that the liquidity support was timely and stress-contingent rather than reflecting permanent relationship characteristics. Third, the liquidity support is concentrated among specific borrower types. We classify firms based on their undrawn credit capacity and financial covenant constraints. Firms with high undrawn capacity and no binding covenant restrictions (which we term "prime borrowers") received 16.6% more credit from high-buffer banks during the crisis. In contrast, firms with binding covenant constraints or those with minimal undrawn commitments received no additional support, suggesting that LCR buffers enable banks to protect established, creditworthy relationships while rationing credit to others.

Related Literature. Credit lines provide firms with liquidity insurance, allowing them to draw on pre-committed funding when external conditions deteriorate. Empirical evidence shows that firms rely heavily on these facilities in stress episodes. Ivashina and Scharfstein (2010) document large drawdowns on existing credit lines during the global financial crisis, while Campello, Graham, and Harvey (2010) and Campello, Giambona, Graham, and Harvey (2011) show that financially constrained firms rely disproportionately on credit lines to manage liquidity shortfalls. From the bank side, these commitments expose intermediaries to liquidity risk, as drawdowns are most likely precisely when funding conditions deteriorate Acharya, Almeida, and Campello (2013). While banks can partially hedge this risk through deposit inflows Gatev and Strahan (2006), shocks to intermediary balance sheets still raise the marginal value of liquidity and reduce lending capacity. At the same time, debt contracts allocate state-contingent control rights to lenders, allowing banks to intervene through covenant enforcement, renegotiation, and amendments rather than through discretionary repricing Roberts and Sufi (2009).

Our analysis contributes to an active debate about whether liquidity regulation provides effective insurance during financial stress. The theoretical case for liquidity buffers rests on the coordination failure problem identified by Diamond and Kashyap (2016) and Kashyap et al. (2024). Both papers argue that bank runs are driven not by insolvency but by depositors' fear of other depositors' fear; the latter tying these fears to bad fundamentals. When sophisticated institutional investors observe ambiguous signals and coordinate on withdrawal, a self-fulfilling panic ensues. The solution is paradoxical: banks must hold buffers that are never actually used. The mere existence of a permanently maintained reserve, like a taxi always waiting at the station, eliminates the incentive to run in the first place. The policy implication is that regulators should design rules that keep liquidity frozen (run prevention) rather than rules that deploy it reactively during stress (run absorption).

However, Nelson (2020) documents that the LCR as currently implemented fails to achieve this paradox. Based on surveys of bank treasurers, he finds that virtually all confirmed they would not use mandated liquidity buffers during stress because doing so invites regulatory scrutiny. Perotti and Suarez (2011) show that when banks are heterogeneous in credit opportunities, a Pigovian tax on short-term liabilities is efficient and preserves credit quality, while quantity-based ratios like the LCR are distortionary. They further demonstrate that liquidity buffers may be least binding precisely when excess credit incentives are strongest, creating procyclicality concerns.

Kiernan, Yankov, and Zikes (2021) show that loan syndicates function as co-insurance arrangements among member banks, where drawdown risk is distributed across syndicate members, creating a network of interbank exposures that pools and redistributes liquidity shocks. They argue that post-LCR implementation, large banks significantly expanded their liquidity provision capacity, and firms with higher credit line reliance increasingly sorted toward syndicates composed of higher-liquidity banks (see, also, Yankov, 2020). Darst, Kokas, Kontonikas, Peydro, and Vardoulakis (2025) demonstrate that banks facing fragile deposit inflows actively reduce their undrawn credit line commitments. This suggests that funding fragility can limit banks' capacity to honor credit line commitments during stress, reinforcing the importance of stable deposit bases for liquidity provision.

The remainder of the paper is organized as follows. Section 2 provides background on the LCR regulation and its implementation in the United States, including the tailoring framework that creates cross-sectional variation in regulatory requirements. Section 3 describes our data sources, combining confidential FR Y-14 bank-firm credit line data with hand-collected LCR disclosures, and discusses measurement considerations for undrawn credit capacity. Section 4 presents our empirical strategy, explaining the triple-difference identification design and the allocation mechanism through syndicate coordination. Section 5 reports our main findings on selective liquidity insurance, including heterogeneity analysis showing that LCR buffers primarily benefit prime borrowers with clean credit profiles. Section 6 concludes. Technical details on sample construction, covenant-adjusted capacity calculations, and the horse race specification testing LCR levels versus buffers are provided in the Appendix.

2 Background

2.1 The Liquidity Coverage Ratio

In response to the 2007-2009 financial crisis, the Basel Committee on Banking Supervision introduced the LCR in 2013 as part of the Basel III framework. The LCR requires internationally active banks to hold sufficient high-quality liquid assets (HQLA) to cover projected net cash outflows over a 30-day stress period. In the United States, the Federal Reserve, Office of the Comptroller of the Currency, and Federal Deposit Insurance Corporation finalized the LCR rule in 2014, with full implementation taking effect in January 2017.

The LCR is defined as:

$$\text{LCR} = \frac{\text{High-Quality Liquid Assets (HQLA)}}{\text{Total Net Cash Outflows over 30 days}}. \tag{1}$$

HQLA include central bank reserves, U.S. Treasuries, and certain high-quality sovereign and corporate securities (with applicable haircuts). Total net cash outflows represent the projected outflows from deposit withdrawals, wholesale funding rollover, and derivative collateral requirements over a 30-day stress scenario, net of capped inflows. Under the original 2014 rule, the full 100% LCR applied to depository institution holding companies with $250 billion or more in total consolidated assets or $10 billion or more in on-balance sheet foreign exposure. A modified 70% LCR applied to certain depository institution holding companies with $50-$250 billion in assets. Some banking organizations below $100 billion in total consolidated assets could also be subject to modified LCR requirements if they had $10 billion or more in on-balance sheet foreign exposure.

2.2 The 2019 Tailoring Framework

In October 2019, U.S. banking regulators finalized a tailoring framework that substantially revised prudential standards, including LCR requirements, based on bank size, complexity, and systemic importance.[2]

The tailoring framework established four categories:

[2] 84 Fed. Reg. 59,230 (Nov. 1, 2019) (Changes to Applicability Thresholds for Regulatory Capital and Liquidity Requirements). The final rule became effective December 31, 2019.

- **Category I** (U.S. Global Systemically Important Banks): U.S. top-tier bank holding companies identified as global systemically important banks under the Board's GSIB surcharge rule. Subject to full 100% LCR with daily reporting.

- **Category II** (Largest Domestic and Foreign Banking Organizations): U.S. top-tier bank holding companies with $700 billion or more in total consolidated assets, or $75 billion or more in cross-jurisdictional activity, consisting of the largest U.S. banking organizations and foreign banking organizations with substantial U.S. operations. Subject to full 100% LCR with daily reporting.

- **Category III** (Large and Complex Banking Organizations): U.S. top-tier bank holding companies with $250 billion or more in total consolidated assets, or $75 billion or more in weighted short-term wholesale funding, nonbank assets, or off-balance sheet exposure, that do not meet Category I or Category II criteria. Subject to reduced 85% LCR with daily reporting.

- **Category IV** (Large Banking Organizations): U.S. top-tier bank holding companies with $100 billion or more in total consolidated assets that do not meet Category I, II, or III criteria. Under the tailoring framework, Category IV firms are subject to LCR requirements only if they have $50 billion or more in weighted short-term wholesale funding. Category IV firms meeting this threshold face a reduced 70% LCR standard. Category IV firms below this threshold are not subject to LCR requirements.

Our analysis sample consists exclusively of banking organizations that remained subject to LCR disclosure requirements following the tailoring framework. Our analysis exploits variation in LCR requirements across banks and the COVID-19 credit drawdown period.

3 Data

Our analysis combines three primary data sources. First, we use Federal Credit Register data known as the FR Y-14 Schedule H.1, which provides quarterly bank-firm credit line data from the Federal Reserve's Comprehensive Capital Analysis and Review (CCAR) stress testing program. This dataset includes committed amounts, utilized amounts, firm characteristics, and covenant information, with coverage starting from 2011Q1 for large bank holding companies subject to CCAR. Second, we hand-collected quarterly LCR reports from more than 35 of the largest banking institutions. Finally, we use the FR Y-9C, which provides quarterly regulatory reports with balance sheet and income data from the Federal Reserve, including total assets, deposits, capital ratios, and loan portfolios. Our final analysis sample spans 32 quarters from 2017Q1 through 2024Q4 and includes 29 bank holding companies with publicly available LCR data that can be matched to the Y-14 credit line data. The panel comprises 174,526 bank-firm-quarter observations, representing 47,876 unique firm-bank relationships observed in the pre-COVID baseline period of 2019Q4.

In our empirical analysis, we construct a High LCR Buffer variable defined as a flag variable for banks with LCR buffer above the median in 2019Q4. The median LCR buffer is 20.0% above the minimum requirement, with mean values of 45.3% for high-LCR buffer banks and 16.0% for low-LCR buffer banks. Similarly, for firms, we construct a flag for firms with undrawn credit lines, as share of total credit line commitments, above the median in 2019Q4. The median undrawn ratio is 65.8%, while the mean is 95.5% for high-undrawn firms and 28.9% for low-undrawn firms. For our shock variables, we define COVID Q1 as a 2020Q1 dummy capturing the March 2020 period of market turmoil and credit line rush. COVID Q2 is a 2020Q2 dummy for the April-June 2020 period of continued uncertainty. We employ bank-level controls to include log of total assets, log of total deposits, Tier 1 capital ratio, and LCR requirement category (Full Daily, Reduced Daily, or Reduced Monthly).

3.1 Measurement Considerations

We consider two measures of firms' undrawn credit line capacity. The standard undrawn ratio captures contractual credit line availability and serves as the standard measure in our study. Credit lines serve as an important liquidity management tool for firms (Lins, Servaes, and Tufano, 2010), and the transmission of bank liquidity shocks through credit line commitments represents a key channel linking bank balance sheets to firm outcomes (Greenwald, Krainer, and Paul, 2025). The second measure we use is a covenant-adjusted undrawn ratio, which accounts for binding financial covenants such as interest coverage and debt-to-EBITDA ratios, thereby capturing economically available credit after covenant restrictions. This measure

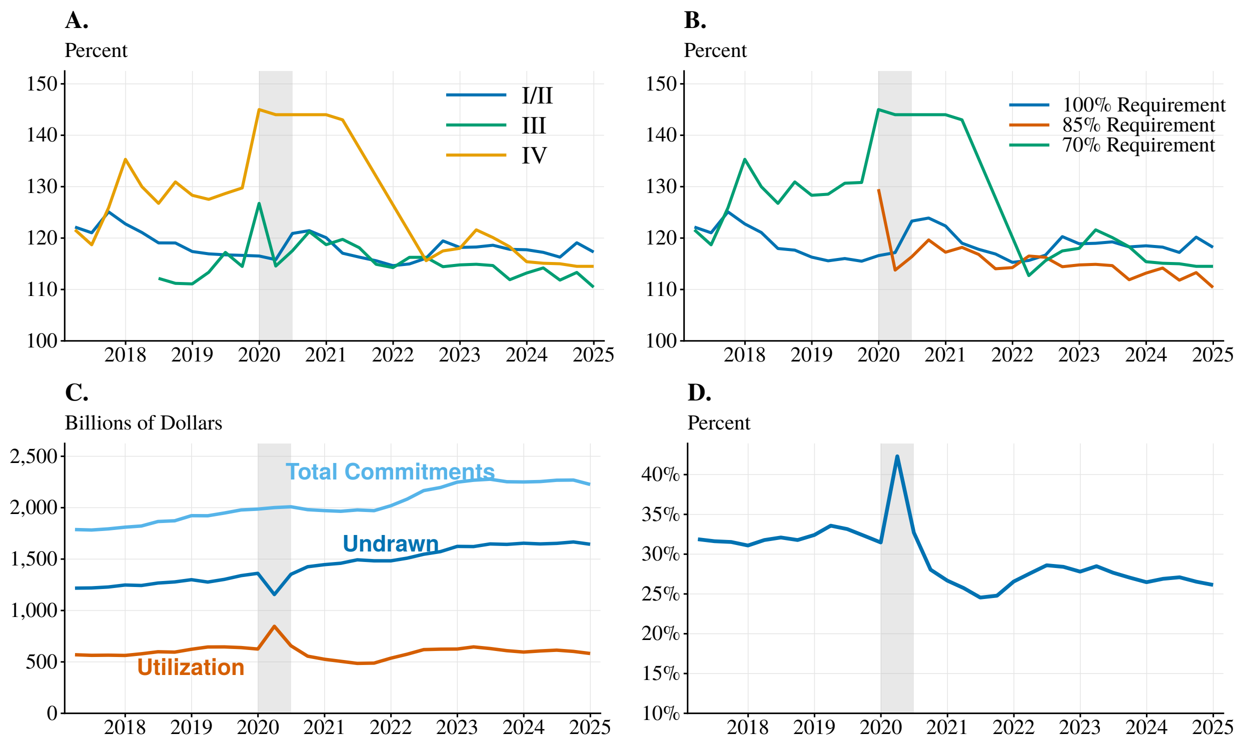

Figure 1: **LCR Buffers and Undrawn Credit Line Capacity: Baseline Summary Statistics.** Panel A displays mean LCR ratios by bank category (I, II, III, IV) from 2017Q1 through 2024Q4. Panel B shows mean LCR ratios by regulatory requirement level (100% full, 85% reduced daily, 70% reduced monthly). Panel C presents aggregate credit line commitments (stacked area) with utilization (teal) and undrawn capacity (coral) in billions of dollars. Panel D shows the aggregate utilization rate as a percentage of total commitments. Gray shading indicates COVID-19 period (2020 Q1-Q2). Source: FR Y-14 Schedule H.1, LCR Public Disclosures.

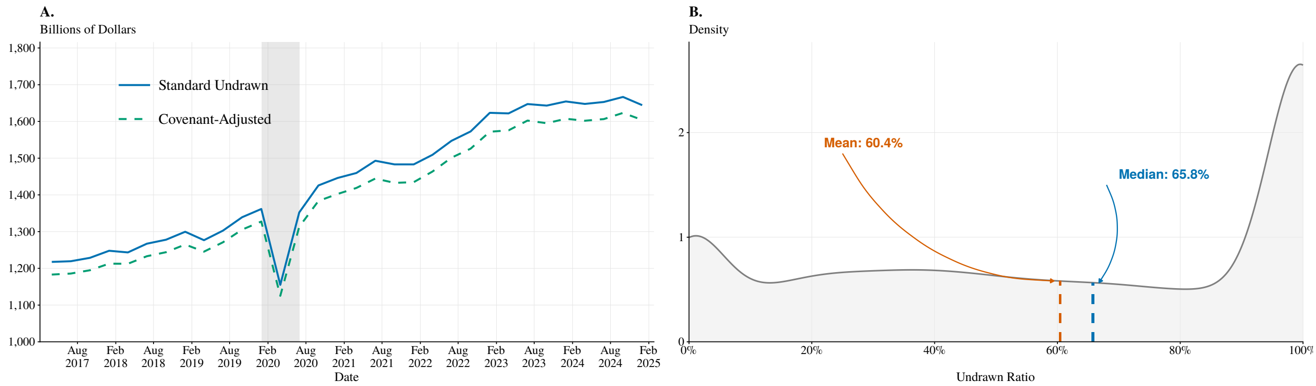

Figure 2: **Distribution of Undrawn Credit Line Capacity: Standard vs. Covenant-Adjusted Measures.** Panel A shows aggregate undrawn credit lines over time (2017-2024), comparing the standard measure (contractual availability) with the covenant-adjusted measure which excludes undrawn amounts that cannot be accessed due to financial covenants. Panel B displays the density distribution of undrawn credit line ratios across firm-bank relationships in 2019Q4, with mean (60.4%) and median (65.8%) marked. Gray shading in Panel A indicates COVID-19 period (2020 Q1-Q2). Source: FR Y-14 Schedule H.1, LCR Public Disclosures.

takes the minimum of contractual undrawn capacity and the borrowing room permitted under covenant constraints.

Firms face two types of financial covenants that limit their borrowing capacity: interest coverage (IC) covenants and debt-to-EBITDA (DE) covenants. Following Greenwald (2019), we use weighted average covenant thresholds of $\kappa = 2.75$ for interest coverage and $\tau = 3.75$ for debt-to-EBITDA. The covenant-adjusted measure calculates the maximum additional debt a firm can borrow before violating either covenant constraint, then takes the minimum of this "debt room" and the contractual undrawn capacity[3].

The correlation between these measures is high ($\rho = 0.948$), but 6.6% of firms switch treatment classification when using the covenant-adjusted measure. These firms reveal important heterogeneity. Covenant-Constrained firms (3.3% of the sample) have high standard undrawn capacity but low covenant-adjusted capacity, with 66% of apparent capacity restricted by financial covenants. In contrast, Marginal Borrowers (3.4%) have low standard undrawn but high covenant-adjusted capacity, indicating firms near the median threshold with no covenant constraints. We use the standard undrawn measure as our primary specification and show covenant-adjusted results as robustness checks (see Figure 2).

[3] See Section 6 and Greenwald (2019) for technical details.

4 Empirical Strategy

4.1 Identification: Triple-Difference Design

We employ a triple-difference specification that compares credit utilization changes during COVID-19 across three dimensions. The first dimension compares banks with high versus low LCR buffers. The second dimension compares firms with high versus low undrawn credit lines. The third dimension compares the COVID-19 period versus the pre-COVID baseline. Our baseline specification estimates the following regression:

$$\begin{aligned}\ln(\text{Utilization}_{ijt}) = {} & \beta_1(\text{High Undrawn}_i \times \text{High LCR Buffer}_j \times \text{COVID}_t) \\ & + \beta_2(\text{High Undrawn}_i \times \text{High LCR Buffer}_j) + \beta_3(\text{High Undrawn}_i \times \text{COVID}_t) \\ & + \beta_4(\text{High LCR Buffer}_j \times \text{COVID}_t) + \gamma \cdot \text{Controls}_{jt} + \alpha_{ij} + \delta_{it} + \varepsilon_{ijt} \qquad (2)\end{aligned}$$

where α_{ij} are Bank$\times$Firm fixed effects, δ_{it} are Firm$\times$Time fixed effects, and ε_{ijt} is the error term. The coefficient of interest is β_1, the triple interaction term.

A statistically significant and positive β_1 would imply that, during COVID, firms with high undrawn lines would have experienced greater utilization increases when borrowing from high-LCR buffer banks compared to high-undrawn firms borrowing from low-LCR buffer banks (capturing the LCR-buffer effect) and compared to low-undrawn firms borrowing from high-LCR buffer banks (capturing treatment intensity). Our baseline period is 2019Q4, the last full quarter before COVID-19. The treatment period is 2020Q1, covering March 2020 when the World Health Organization declared a pandemic amid financial market stress and a rush to draw credit lines. For extended analysis, we also examine 2020Q2, which captures continued uncertainty and policy responses. The full panel spans 2017Q1 to 2024Q4, providing pre-trends and longer-run effects.

Comparing high-LCR buffer versus low-LCR buffer banks during COVID requires controlling for firm demand to isolate bank supply effects. If large firms with greater precautionary demand disproportionately bank with high-LCR buffer institutions (e.g., Category I GSIBs), then higher credit utilization at these banks during COVID could reflect firm demand rather than bank supply. Firms banking with high-LCR buffer institutions may differ systematically by size, industry, creditworthiness, or liquidity management strategies, and these differences may generate different credit demand patterns during stress. The triple-difference design addresses this concern through multiple identification features. Firm×Time fixed effects (δ_{it}) absorb all firm-specific shocks to credit demand, including COVID-19 demand shocks, ensuring that identification comes purely from variation in bank supply to the same firm. Bank×Firm fixed effects (α_{ij}) absorb time-invariant relationship characteristics such as relationship length, pricing, and covenants. The interaction with firm-level undrawn exposure captures treatment intensity, as we expect LCR insurance effects to be strongest for firms most exposed to credit supply shocks, specifically those with large undrawn commitments.

Why are high-undrawn firms most exposed to credit supply shocks? Unlike cash holdings on the balance sheet, credit lines represent contingent promises from banks rather than guaranteed liquidity. Firms with large undrawn commitments structure their liquidity management around the expectation of accessing these credit lines during stress periods. During the COVID-19 crisis, firms rushed to draw credit lines simultaneously as a precautionary response to unprecedented uncertainty, creating what Acharya and Steffen (2020) describe as a "dash for cash." This simultaneous drawdown pressure tests banks' ability and willingness to honor commitments. Firms with large undrawn lines face the greatest exposure to this credit supply channel because they depend most heavily on banks' capacity to accommodate drawdowns. Banks with stronger liquidity positions, as measured by high LCR buffers, should be better positioned to honor these commitments during stress.

4.2 The Allocation Mechanism: Syndicate Coordination

Our identification strategy exploits within-firm variation across multiple bank relationships through Firm×Time fixed effects. This naturally raises a mechanism question: when a firm with multiple bank relationships needs liquidity during stress, why would it draw more heavily from banks with higher LCR buffers rather than distributing draws evenly across all lenders? The answer lies in the structure of corporate credit markets and the role of bank syndicates in coordinating liquidity provision.

Most large corporate credit lines in our sample are syndicated arrangements, where multiple banks share exposure to a single borrower according to contractual participation shares. Kiernan et al. (2021) show that these syndicates function not merely as passive credit allocation mechanisms but as active co-insurance arrangements among member banks. When a borrower draws on a syndicated credit line, the drawdown is distributed across syndicate members, creating a network of interbank exposures that effectively pools and redistributes liquidity shocks across the banking system. Importantly, their analysis demonstrates that post-LCR implementation, large banks significantly expanded their liquidity provision capacity, providing direct evidence that liquidity regulation reshaped the supply side of corporate credit lines.

The syndicate structure creates natural coordination mechanisms that can direct liquidity flows toward banks with available capacity. Lead arrangers, who typically manage the syndicate and coordinate borrower-bank interactions, may explicitly or implicitly steer drawdowns toward syndicate members with stronger liquidity positions during stress periods. Alternatively, contractual terms in syndicated credit agreements may specify allocation rules that account for bank capacity constraints. Kiernan et al. (2021) further document assortative matching in credit markets: firms with higher credit line reliance have increasingly sorted toward syndicates composed of higher-liquidity banks post-LCR, suggesting that both borrowers and arrangers internalize bank liquidity quality when structuring credit relationships.

Our triple-difference design captures this allocation mechanism in a specific way. The Firm$\times$Time fixed effects absorb the total amount a firm wishes to draw across all its bank relationships in a given quarter, holding constant firm-level credit demand. The triple interaction coefficient β_1 then identifies whether that firm-level demand is disproportionately accommodated by the firm's high-buffer banks, and whether this differential accommodation is stronger for firms with large undrawn commitments (high treatment intensity). If syndicates coordinate to direct draws toward banks with room above the regulatory minimum (the "last taxi" buffer), we would observe exactly this pattern: high-undrawn firms shift borrowing toward their high-buffer banks during stress, even after controlling for total firm demand and time-invariant relationship characteristics.

5 Results

5.1 Main Findings: Selective Liquidity Insurance

Table 1 presents our baseline triple-difference estimates. We present results for both the covenant-adjusted undrawn measure (columns 1-2) and the standard undrawn measure (columns 3-6), examining the effects during COVID Q1 (2020Q1) and COVID Q2 (2020Q2). All specifications include bank-level controls (log total assets, log total deposits, Tier 1 capital ratio, and LCR requirement category), Bank×Firm fixed effects, and Firm×Time fixed effects, with standard errors clustered at the bank×time and firm levels.

Focusing on the standard undrawn measure in columns 3-4 for COVID Q1, we find that the triple interaction coefficient is 0.100, statistically significant at the 10% level. This indicates that high-undrawn firms at high-LCR buffer banks increased credit line utilization 10.5% more than comparison groups during the acute phase of the COVID-19 crisis. With Bank×Firm and Firm×Time fixed effects, the triple interaction is the cleanly identified coefficient of interest, as these fixed effects absorb all firm-level credit demand shocks and time-invariant relationship characteristics.

Columns 7-8 add the continuous LCR ratio as a control to test whether the buffer effect survives when controlling for the level of bank liquidity. The triple interaction coefficient remains unchanged and statistically significant at 0.100, while the continuous LCR variable enters significantly at 0.001. This indicates that each additional percentage point of LCR increases credit provision to high-undrawn firms by approximately 0.1% during the crisis. The robustness of the buffer effect to including continuous LCR provides initial evidence that buffers above the regulatory minimum, not just overall liquidity levels, drive the insurance effect. We explore this distinction more directly in the appendix (Table 4) with a horse race specification that simultaneously includes both LCR level and buffer interactions.

The economic magnitude is meaningful but more modest than the raw coefficient suggests. The 0.100 coefficient on the triple interaction indicates that during COVID-19, high-undrawn firms shifted 10.5% more borrowing toward their high-LCR buffer banks (and away from low-LCR buffer banks) compared to low-undrawn firms. The Firm×Time fixed effects ensure identification comes from within-firm variation across different bank relationships at the same point

	Covenant-Adj.		Standard Undrawn Measure					
	COVID Q1		COVID Q1		COVID Q2		COVID Q1 + LCR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Triple Interaction:								
High Undrawn × High LCR Buffer × COVID	0.072	0.072	0.099*	0.100*	0.004	0.004	0.100*	0.100*
	(1.33)	(1.32)	(1.69)	(1.68)	(0.11)	(0.11)	(1.68)	(1.68)
Double Interactions:								
High Undrawn × COVID	−0.012	−0.012	−0.039	−0.038	−0.221***	−0.221***	−0.039	−0.038
	(−0.21)	(−0.19)	(−0.56)	(−0.55)	(−2.76)	(−2.76)	(−0.56)	(−0.54)
High LCR Buffer × COVID	−0.037	−0.041	−0.048*	−0.052*	0.004	0.011	−0.046*	−0.050*
	(−1.47)	(−1.62)	(−1.82)	(−1.96)	(0.19)	(0.46)	(−1.73)	(−1.84)
Controls:								
Continuous LCR Ratio							0.001**	0.001**
							(2.01)	(2.12)
Log(Bank Total Assets)	0.314***	0.445***	0.313***	0.445***	0.311***	0.446***	0.329***	0.434***
	(5.12)	(3.57)	(5.11)	(3.58)	(5.08)	(3.66)	(5.33)	(3.50)
Log(Bank Total Deposits)		−0.109		−0.109		−0.111		−0.082
		(−0.96)		(−0.96)		(−1.01)		(−0.73)
Bank Tier 1 Capital Ratio		−1.471***		−1.471***		−1.479***		−1.561***
		(−2.59)		(−2.59)		(−2.61)		(−2.79)
LCR Requirement Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	174,526	174,526	174,526	174,526	174,526	174,526	174,526	174,526
Adjusted R-squared	0.862	0.862	0.862	0.862	0.862	0.862	0.862	0.862
Fixed Effects:								
Firm × Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank × Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Bank×Time, Firm		Bank×Time, Firm		Bank×Time, Firm		Bank×Time, Firm	

Table 1: **Baseline Triple-Difference Estimates: LCR Buffers and Credit Line Utilization During COVID-19.** The dependent variable is log(credit line utilization). The log transformation requires non-zero utilization, which restricts the sample to active borrowing relationships (approximately 45% of all firm-bank observations have zero utilization and are excluded). High Undrawn is a dummy for firms with undrawn credit lines above median (65.8%) in 2019Q4. High LCR Buffer is a dummy for banks with LCR buffer above median (20.0%) in 2019Q4. Columns (1)–(2) use covenant-adjusted undrawn measure. Columns (3)–(6) use standard undrawn measure. Columns (7)–(8) add continuous LCR ratio as a control. COVID Q1 equals one for 2020Q1; COVID Q2 equals one for 2020Q2. All specifications include Bank×Firm and Firm×Time fixed effects; the triple interaction is the cleanly identified coefficient of interest. t-statistics are reported in parentheses using standard errors clustered at the Bank×Time and Firm levels, where * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

in time, absorbing all firm-level credit demand. The Bank×Firm fixed effects control for time-invariant relationship characteristics. Together, these fixed effects isolate how the within-firm borrowing gap between high-LCR buffer and low-LCR buffer bank relationships changed differently for high-undrawn versus low-undrawn firms during the crisis. To interpret this in dollar terms, Prime Borrowers (who drive the effect) have average baseline utilization of \$2.1M in

2019Q4, representing a 5.8% utilization rate on their \$40.7M in total commitments. The 10.5% increase on this baseline utilization implies roughly \$0.2M in additional credit per firm-bank relationship during the crisis, or equivalently, about 0.5 percentage points of their committed credit lines. While this appears small in dollar terms, it represents meaningful support during a period of acute market stress when firms were scrambling for liquidity.

The temporal pattern in columns 5-6 reveals that the LCR insurance effect was specific to the acute stress period. By 2020Q2, the triple interaction coefficient becomes insignificant, indicating high-LCR buffer banks no longer differentiated their support between high and low undrawn firms. Strikingly, the High Undrawn $\times$ COVID coefficient becomes large and negative in Q2, showing that high-undrawn firms reduced utilization by 23% in Q2 after drawing heavily in Q1. The Q2 pattern confirms that the March 2020 drawdowns represented precautionary demand responding to acute uncertainty, not permanent shifts in credit relationships. The fact that high-undrawn firms paid back their drawdowns in Q2 while the LCR insurance effect disappeared demonstrates that the liquidity support was timely and temporary, activating precisely when needed and subsiding as conditions normalized. This temporal specificity strengthens the interpretation that LCR buffers enabled banks to provide insurance during acute stress rather than permanently distorting credit allocation.

Using covenant-adjusted undrawn ratios in columns 1-2, the triple interaction becomes smaller and loses statistical significance. This reduction occurs because the two measures classify treatment groups differently. Under the standard measure, the "high undrawn" treatment group consists of 93.8% Prime Borrowers (with strong positive effects) and 6.2% Covenant-Constrained firms. Under the covenant-adjusted measure, the treatment group consists of 93.7% Prime Borrowers and 6.3% Marginal Borrowers who experience no significant effects from high-LCR buffer banks. This compositional difference dilutes the estimated treatment effect and reduces statistical power. The heterogeneity analysis below investigates which types of firms drive the liquidity insurance effect.

5.2 Heterogeneity Analysis

Why does the covenant-adjusted measure produce weaker results? We investigate treatment effect heterogeneity by splitting firms into four groups based on their classification under both measures. Prime Borrowers (49.7% of the sample, n=23,796) have high undrawn capacity in both measures, indicating clean, established relationships with average undrawn commitments of \$38.6M. Low-Undrawn Borrowers (43.7%, n=20,912) have low undrawn capacity in both measures, indicating low exposure with average undrawn of \$8.2M. Covenant-Constrained firms (3.3%, n=1,562) have high standard undrawn (89.8%) but low covenant-adjusted capacity (30.5%), with average undrawn of \$14.3M. The covenant restrictions reduce their available capacity by 66% relative to the contractual amount. Marginal Borrowers (3.4%, n=1,606) have low standard undrawn (62.4%) but high covenant-adjusted capacity (62.3%), indicating firms near the median threshold with no covenant constraints and average undrawn of \$22.3M.

Table 2 and Figure 3 present the change in log credit line utilization from 2019Q buffer versus high-LCR buffer banks. As with the regression analysis, the log specification restricts the sample to relationships with non-zero utilization in both periods, ensuring we measure the intensive margin of credit supply (how much existing borrowers drew down) rather than the extensive margin (whether firms borrow at all). The table reveals striking heterogeneity in how different types of firms benefited from bank LCR buffers during the crisis.

Firm Group	Low LCR Buffer	High LCR Buffer	Difference
Prime Borrowers	58.9	74.3	−15.4***
	(4,821)	(2,620)	
Low-Undrawn Borrowers	−3.2	−5.4	+2.1**
	(13,158)	(6,052)	
Covenant-Constrained	42.7	33.6	+9.1
	(437)	(261)	
Marginal Borrowers	7.0	2.5	+4.5
	(895)	(528)	

Table 2: **COVID-19 Credit Response by Borrower Type.** Change in log credit line utilization from 2019Q4 to 2020Q1 (log points). Difference = Low LCR Buffer − High LCR Buffer; negative values indicate high-LCR buffer banks provided more credit. Sample sizes in parentheses. *** $p < 0.001$, ** $p < 0.01$. See text for group definitions and baseline characteristics.

The results show that the LCR liquidity insurance effect is concentrated entirely in Prime Borrowers. These clean borrower relationships comprise the largest group (49.7% of the sample) and have the largest undrawn lines (\$38.6M average, compared to \$8.2M for Low-Undrawn Borrowers) with no binding covenant constraints. High LCR Buffer banks provided 15.4 log points more credit to these firms ($p < 0.001$), representing 16.6% more credit from high-LCR

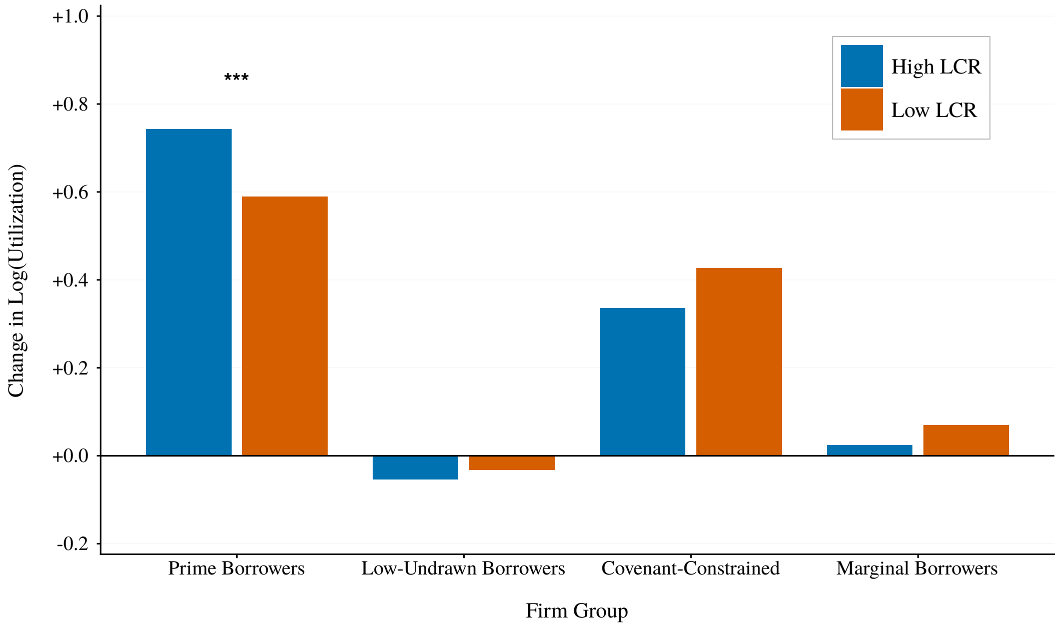

Figure 3: **Heterogeneous Effects by Borrower Type.** Figure displays changes in log credit line utilization from 2019Q4 to 2020Q1 for different firm groups, separately for firms borrowing from low-LCR buffer versus high-LCR buffer banks. Firm groups are classified based on standard versus covenant-adjusted undrawn capacity measures: Prime Borrowers (high in both), Low-Undrawn Borrowers (low in both), Covenant-Constrained (high standard, low covenant-adjusted), and Marginal Borrowers (low standard, high covenant-adjusted). Source: FR Y-14 Schedule H.1, LCR Public Disclosures.

buffer banks relative to low-LCR buffer banks during the acute phase of the crisis.

In contrast, other firm groups experienced no additional support from high-LCR buffer banks. For Low-Undrawn Borrowers (43.7% of the sample), which have minimal undrawn commitments ($8.2M average), high-LCR buffer banks and low-LCR buffer banks behaved differently, with low-LCR buffer banks showing less negative response, though this difference is economically small (+2.1%, $p = 0.007$). For Covenant-Constrained firms (3.3% of the sample, n=1,562), despite having high gross undrawn ratios (89.8%), binding covenants reduce their available capacity to 30.5%, restricting 66% of apparent borrowing room. Their average undrawn of $14.3M is substantially below Prime Borrowers. High LCR buffer banks provided 9.5% less credit to these firms, though this difference is not statistically significant ($p = 0.358$). For Marginal Borrowers (3.4% of the sample, n=1,606) near the median threshold with no covenant issues and $22.3M average undrawn, high-LCR buffer banks provided 4.6% less credit, though this difference is not statistically significant ($p = 0.348$).

The heterogeneity results reveal that LCR buffers enable selective, not universal, liquidity insurance. Banks with high LCR buffers support high-quality relationships, as Prime Borrowers with clean credit profiles and substantial undrawn commitments received significantly more credit. However, they ration credit to others, as Covenant-Constrained and Marginal Borrowers received no additional support or were cut more.

6 Conclusion

Using granular bank-firm credit data and hand-collected LCR disclosures, we find that the Liquidity Coverage Ratio provides selective liquidity insurance during financial stress, but only through buffers above the regulatory minimum. Banks with higher LCR buffers provided significantly more credit to firms with large undrawn credit lines during the COVID-19 crisis in March 2020, but only to high-quality borrowers with clean credit profiles and no covenant constraints. Critically, we show that when both LCR level and buffer are included simultaneously, only the buffer matters. This supports the "last taxi" interpretation that banks treat the regulatory minimum as a binding floor they will not breach, meaning only buffers above this threshold enable liquidity provision during stress.

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Technical Appendix

Sample Construction Details

Our sample construction proceeds in five steps:

1. **Extract FR Y-14 H.1 credit line data (2017Q1-2024Q4):** Starting with 2.8M bank-firm-quarter records, we restrict to credit lines and exclude term loans, yielding 2.1M observations.

2. **Merge LCR disclosure data:** We hand-collected 669 quarterly PDF reports from 35+ banks and extracted LCR ratios, HQLA, and total net cash outflows. Match rate: 95% of Y-14 observations.

3. **Create treatment variables (2019Q4 baseline):**

   - LCR buffer = LCR ratio − regulatory requirement (100%, 85%, or 70%)
   - High LCR Buffer flag = above median (20.0%)
   - Undrawn ratio = (Committed Credit Lines − Utilized Credit Lines) / Committed Credit Lines
   - High undrawn flag = above median (65.8%)

4. **Restrict sample for identification:** Require firms observed with multiple banks (for within-firm variation) and bank-firm pairs observed both pre- and post-COVID. After dropping firms with missing covenant data: 174,526 observations remain.

5. **Create switcher group classifications:** Compare standard versus covenant-adjusted undrawn flags and classify firms as Low-Undrawn Borrowers, Prime Borrowers, Covenant-Constrained, or Marginal Borrowers.

Estimation Approach

The baseline specification (Table 1, Columns 3-4) estimates:

$$\begin{aligned}\ln(\text{Utilization}_{ijt}) = {} & \beta_1(\text{High Undrawn}_i \times \text{High LCR Buffer}_j \times \text{COVID}_t) \\ & + \beta_2(\text{High Undrawn}_i \times \text{High LCR Buffer}_j) + \beta_3(\text{High Undrawn}_i \times \text{COVID}_t) \\ & + \beta_4(\text{High LCR Buffer}_j \times \text{COVID}_t) + \gamma \cdot \text{Controls}_{jt} + \alpha_{ij} + \delta_{it} + \varepsilon_{ijt} \quad (3)\end{aligned}$$

where α_{ij} are Bank×Firm fixed effects, δ_{it} are Firm×Time fixed effects, and standard errors are clustered at the Bank×Time and Firm levels.

The heterogeneity analysis (Table 2) compares mean utilization changes across groups. For each firm group g, we calculate:

$$\Delta\text{Utilization}_{ig} = \ln(\text{Utilization}_{i,2020Q1}) - \ln(\text{Utilization}_{i,2019Q4}) \quad (4)$$

We then compute group means by LCR level:

$$\bar{\Delta}^g_{\text{Low LCR Buffer}} = \frac{1}{N^g_{\text{Low}}} \sum_{i \in g, \text{Low LCR Buffer}} \Delta\text{Utilization}_{ig} \quad (5)$$

$$\bar{\Delta}^g_{\text{High LCR Buffer}} = \frac{1}{N^g_{\text{High}}} \sum_{i \in g, \text{High LCR Buffer}} \Delta\text{Utilization}_{ig} \quad (6)$$

The difference is:

$$\text{LCR Effect}^g = \bar{\Delta}^g_{\text{Low LCR Buffer}} - \bar{\Delta}^g_{\text{High LCR Buffer}} \quad (7)$$

Statistical significance is assessed using a two-sample t-test:

$$t = \frac{\bar{\Delta}^g_{\text{Low LCR Buffer}} - \bar{\Delta}^g_{\text{High LCR Buffer}}}{\sqrt{\frac{s^2_{\text{Low}}}{N^g_{\text{Low}}} + \frac{s^2_{\text{High}}}{N^g_{\text{High}}}}} \quad (8)$$

where s^2_{Low} and s^2_{High} are the sample variances for each group.

Variable Definitions

Variable	Construction	Source
Log(Utilization)	Log(credit line utilization)	FR Y-14 H.1
Undrawn Ratio	(Committed − Utilized) / Committed	FR Y-14 H.1
Covenant-Adjusted Undrawn Ratio	min(Undrawn, Covenant Room) / Committed	FR Y-14 H.1
LCR Buffer	LCR ratio − regulatory requirement	LCR Disclosures
Log(Total Assets)	Log(total assets)	FR Y-9C
Tier 1 Capital Ratio	Tier 1 capital ratio	FR Y-9C
COVID Q1	=1 if 2020Q1	Constructed

Table 3: **Variable Definitions.** The table provides definitions and data sources for key variables used in the empirical analysis. FR Y-14 H.1 refers to FR Y-14 Schedule H.1 credit line data from CCAR stress testing. FR Y-9C refers to consolidated financial statements for bank holding companies. LCR disclosures are hand-collected from public quarterly reports. Regulatory requirement varies by bank designation: 100% for Category I GSIBs, 85% for reduced daily reporting banks, and 70% for reduced monthly reporting banks.

Covenant-Adjusted Capacity Calculation

This section provides the detailed mathematical derivation of the covenant-adjusted undrawn capacity measure.

Interest Coverage (IC) Covenant The IC covenant requires that $\text{EBITDA}/\text{Interest} \geq \kappa$, where $\kappa = 2.75$ following Greenwald (2019). The debt room under the IC covenant represents the maximum additional debt D_{IC} a firm can borrow before violating its interest coverage requirement.

If the firm borrows additional amount D_{IC}, its new interest expense becomes $\text{Interest} + D_{\text{IC}} \times r$, where r is the average interest rate on the firm's debt. The constraint requires:

$$\frac{\text{EBITDA}}{\text{Interest} + D_{\text{IC}} \times r} \geq \kappa \tag{9}$$

Multiplying both sides by the denominator and rearranging:

$$\text{EBITDA} \geq \kappa \times (\text{Interest} + D_{\text{IC}} \times r) \tag{10}$$

$$\text{EBITDA} \geq \kappa \times \text{Interest} + \kappa \times D_{\text{IC}} \times r \tag{11}$$

$$\text{EBITDA} - \kappa \times \text{Interest} \geq \kappa \times D_{\text{IC}} \times r \tag{12}$$

Solving for D_{IC} yields:

$$\text{Debt Room}_{\text{IC}} = \frac{\text{EBITDA} - \kappa \times \text{Interest}}{\kappa \times r} = \frac{\frac{\text{EBITDA}}{\kappa} - \text{Interest}}{r} \tag{13}$$

Debt-to-EBITDA (DE) Covenant The DE covenant requires that Debt/EBITDA $\leq \tau$, where $\tau = 3.75$ following Greenwald (2019). If the firm borrows additional amount D_{DE}, the constraint requires:

$$\frac{\text{Debt} + D_{\text{DE}}}{\text{EBITDA}} \leq \tau \tag{14}$$

Multiplying both sides by EBITDA and rearranging:

$$\text{Debt} + D_{\text{DE}} \leq \tau \times \text{EBITDA} \tag{15}$$

$$D_{\text{DE}} \leq \tau \times \text{EBITDA} - \text{Debt} \tag{16}$$

Therefore:

$$\text{Debt Room}_{\text{DE}} = \tau \times \text{EBITDA} - \text{Debt} \tag{17}$$

Combined Borrowing Capacity The firm's actual unused borrowing capacity is constrained by three factors: the credit line limit, the IC covenant, and the DE covenant. The binding constraint is:

$$\text{Actual Unused Capacity} = \min(\text{Unused Capacity}, \text{Debt Room}_{\text{IC}}, \text{Debt Room}_{\text{DE}}) \tag{18}$$

Numerical Example Consider a firm with \$10M EBITDA, \$2M interest expense, \$25M total debt, a 5% average interest rate, and \$50M stated unused capacity. The IC debt room is:

$$\text{Debt Room}_{\text{IC}} = \frac{\frac{10}{2.75} - 2}{0.05} = \frac{3.636 - 2}{0.05} = \frac{1.636}{0.05} = \$32.73\text{M} \tag{19}$$

The DE debt room is:

$$\text{Debt Room}_{\text{DE}} = 3.75 \times 10 - 25 = 37.5 - 25 = \$12.5\text{M} \tag{20}$$

The actual unused capacity is therefore:

$$\text{Actual Unused Capacity} = \min(50, 32.73, 12.5) = \$12.5\text{M} \tag{21}$$

Despite having \$50M in stated capacity, the debt-to-EBITDA covenant restricts available borrowing to only \$12.5M, representing a 75% reduction in apparent capacity. If the firm borrows the full \$12.5M, its new debt-to-EBITDA ratio would be $(25 + 12.5)/10 = 3.75$, exactly at the covenant limit.

Horse Race: LCR Level vs. Buffer

Table A1 presents the horse race specification that includes both LCR level and LCR buffer interactions in the same regression. This test directly addresses whether the "last taxi" interpretation is correct: if banks treat the 100% minimum as a binding floor, then only buffers above this floor (not the level itself) should predict differential lending during stress. Column (1) includes minimal controls; column (2) includes full bank-level controls.

The results strongly support the buffer interpretation. When both LCR level and buffer are included, the triple interaction with LCR buffer remains significant at 0.093 ($t = 1.80$), while the triple interaction with LCR level is effectively zero at 0.016 ($t = 0.31$). The continuous LCR ratio is also significant at 0.001 ($t = 2.00$), suggesting that each additional percentage point of LCR matters. This horse race provides decisive evidence that buffers above the regulatory minimum, not overall LCR levels, determine banks' capacity to provide liquidity insurance during stress.

	COVID Q1	
	(1)	(2)
LCR Level Interactions:		
High Undrawn × High LCR Level × COVID	0.016	0.018
	(0.31)	(0.35)
High LCR Level × COVID	0.006	0.008
	(0.26)	(0.33)
LCR Buffer Interactions:		
High Undrawn × High LCR Buffer × COVID	**0.093***	**0.093***
	(1.80)	**(1.78)**
High LCR Buffer × COVID	−0.048*	−0.052**
	(−1.89)	(−2.02)
Other Interactions:		
High Undrawn × COVID	−0.040	−0.038
	(−0.56)	(−0.54)
Controls:		
Continuous LCR Ratio	0.001**	0.001**
	(2.00)	(2.10)
Log(Bank Total Assets)	0.327***	0.435***
	(5.31)	(3.53)
Log(Bank Total Deposits)		−0.085
		(−0.76)
Bank Tier 1 Capital Ratio		−1.565***
		(−2.79)
LCR Requirement Category	Yes	Yes
Observations	174,526	174,526
Adjusted R-squared	0.862	0.862
Fixed Effects:		
Firm × Time FE	Yes	Yes
Bank × Firm FE	Yes	Yes
Clustering	Bank×Time, Firm	

Table 4: **Horse Race: LCR Level vs. Buffer.** The dependent variable is log(credit line utilization). This specification includes BOTH LCR level and LCR buffer interactions simultaneously to test which matters for lending during stress. High LCR Level is a dummy for banks with LCR ratio above median in 2019Q4. High LCR Buffer is a dummy for banks with LCR buffer (LCR ratio − 100%) above median in 2019Q4. High Undrawn is a dummy for firms with undrawn credit lines above median in 2019Q4 (standard measure). Columns (1)–(2) examine the COVID Q1 period (2020Q1). The key result is that the buffer triple interaction is significant while the level triple interaction is not, supporting the "last taxi" interpretation that banks treat 100% as a binding floor. All specifications include Bank×Firm and Firm×Time fixed effects. t-statistics are reported in parentheses using standard errors clustered at the Bank×Time and Firm levels, where * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.