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Liquidity Regulation and Financial Intermediaries

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Abstract

The liquidity-coverage ratio (LCR) requires banks to hold enough liquidity to withstand a 30-day run. We study the effects of the LCR on broker-dealers, the financial intermediaries at the epicenter of the 2007–2009 crisis. The LCR brings some financial-stability benefits, including a significant maturity extension of triparty repos backed by lower-quality collateral, as well as the accumulation of larger liquidity pools. However, it also leads to less liquidity transformation by broker-dealers. We also discuss the liquidity risks not addressed by the LCR. Finally, we show that a major source of fire-sale risk was self-corrected before the introduction of postcrisis regulations.

I. Introduction

At the peak of the cycle in 2006, broker-dealers (*dealers* hereafter) were financing a significant fraction of their illiquid assets overnight on the repo markets. The need to roll over overnight repos to finance illiquid positions exposed the dealers to significant fire-sale losses once funding markets froze. Facing severe runs on their funding and with insufficient liquidity pools, several dealers ceased operations, including, most famously, Bear Stearns and Lehman Brothers. Ultimately, as Diamond (2008) pointed out, "financial crises are everywhere and always due to problems of short-term debt," leading to the need for "appropriate levels of liquidity" (Diamond (2018)).

In the aftermath of the financial crisis, steps were taken by regulators and policy makers worldwide to address several vulnerabilities in the banking system. Notably, the Basel Committee introduced the liquidity-coverage ratio (LCR), which

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requires banks to hold enough high-quality liquid assets (HQLAs) that can be readily converted into cash to meet the liquidity needs arising from a hypothetical 30-day run. After the Basel Committee finalized the LCR rule, each constituent country was tasked with implementing its own versions of the rule, with the U.S. implementation ending up as one of the most stringent.

Although the purpose of the LCR is clear, its effects (both intended and unintended) are not yet fully understood: We do not yet know whether the LCR made the system more resilient, and if so, along which dimensions; we also do not know whether the LCR created any unintended source of instability. An even deeper question is whether, in the aftermath of the crisis, financial institutions reduced their vulnerabilities before any new regulation forced them to or whether they did so only once required by new regulations.

This article addresses these questions, focusing on the effect of the LCR on the largest dealers operating in U.S. financial markets. Because of both data availability and the fact that the dealers subject to the LCR are significantly larger, more complex, and more involved in market making and repo activities than the dealers not subject to the LCR, we estimate the LCR effects within the sample of dealers subject to it. Among these LCR-affected dealers operating in the United States, domestic dealers are subject to the U.S. LCR implementation, whereas dealers affiliated with foreign bank holding companies (foreign dealers) are subject to their respective foreign implementations.[1] Identification then relies on the fact the U.S. implementation of the LCR was quicker and more stringent than that of most foreign countries.

Using confidential data on dealers' financing and inventories, together with detailed triparty repo transactions, we uncover three main effects that are consistent with LCR incentives and the timing of implementation. First, the LCR induces dealers to increase the maturity of triparty repos backed by lower-quality collateral while leaving the maturity structure of repos backed by high-quality collateral unchanged. Second, the LCR leads dealers to reduce their reliance on repos as a way to finance inventories of high-quality assets, resulting in more of these inventories counting toward HQLA, hence increasing the LCR.[2] Third, the LCR leads to a reduction in the collateral upgrades that dealers provide to their clients. Collateral upgrades for clients are indeed penalized under the LCR because they amount to a deterioration in the asset quality of the dealer.

Each of these changes appears to de-risk dealers' operations to various degrees. The longer maturity of repos backed by lower-quality collateral seems to improve stability. Dealers finance a sizable portion of their lower-quality inventories on the repo market, albeit less so than precrisis. As a result, access to longer-term repos backed by lower-quality collateral reduces rollover risk and possible fire-sale losses in a stress event. Dealers also borrow in the repo market to finance clients' leverage. Therefore, dealers can pass some of these maturity-extension

[1]The term *domestic* (or *U.S.*) *dealers* refers to the domestic broker-dealer subsidiaries of U.S. financial institutions (e.g., J.P. Morgan Securities LLC); the term *foreign dealers* refers to U.S. subsidiaries of foreign financial institutions (e.g., HSBC Securities (USA) Inc.).

[2]Securities count toward HQLA requirements only if unencumbered. By pledging a security as collateral in a repo transaction, it becomes encumbered because a third party now has a right on it. As a result, the security being repoed out stops counting toward HQLA requirements.

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benefits to their hedge-fund clients, reducing their rollover risk. Unless otherwise noted, *repos* refers to all secured funding raised by the dealer (including securities lending), and similarly, *reverse repos* refers to all secured funding provided by the dealer to its clients (including securities borrowing).

Next, the reduced reliance on repos to finance Treasury inventories improves dealers' stability, but only indirectly. Reliance on overnight repos to fund Treasuries does not pose direct fire-sale risk in case these repos do not roll because Treasuries are the most liquid assets and tend to appreciate during stress events. However, having more unencumbered Treasuries increases the size of dealers' liquidity pools that can be monetized in case of a run. The importance of maintaining large liquidity pools is highlighted on several occasions in the Financial Crisis Inquiry Commission (FCIC) report, where regulators discuss how Lehman's liquidity pools were not sufficient to withstand a severe run.[3]

Reliance on repos to finance inventories becomes a source of fire-sale risk only to the extent that repos do not roll while the underlying collateral becomes illiquid (or loses significant value). In this regard, we estimate that a significant reduction in the reliance on repos to finance riskier and less liquid collateral occurred right after the 2007–2009 crisis and before the LCR was even announced. In particular, domestic dealers significantly relied on repos to finance inventories of corporate debt precrisis: Approximately 40% of their corporate debt inventories were financed with overnight (and open) repos. In the immediate aftermath of the crisis (before the LCR has been announced), the number drops from 40% to roughly 10%. This finding suggests an endogenous de-risking that occurred right after the crisis: Cash lenders and dealers identified this precrisis practice as too risky and scaled it back autonomously.[4] This finding also complements the observation that large dealers have been more reluctant to take inventory risks postcrisis (Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018), Goldstein and Hotchkiss (2020), and Schultz (2017)).

The third estimated LCR effect, namely, the reduction in collateral upgrades for clients, has uncertain financial-stability implications during a stress scenario but reduces the everyday liquidity-enhancement services provided by dealers to their clients.[5] The implementation of initial and variation margins for noncleared derivatives has been gradually phased in, with the last set of market participants having to comply by Sept. 2020.[6] This may create significant demand for dealers to upgrade

[3]Chief among them is the remark that in June 2008, "regulators' most recent stress test showed that Lehman would need $15 billion more than the $54 billion in its liquidity pool to survive a loss of all unsecured borrowings and varying amounts of secured borrowings." See the FCIC report on pages 284, 328, and 363. The previous citation is from page 328.

[4]It is worth noting that the LCR rule nevertheless penalizes this practice of financing lower-quality collateral with short-term repos. For more details, see Section A.1 of the Appendix.

[5]Decreased collateral upgrades for clients likely lead to a safer regulated banking system; however, it implies that increased risk is borne by nonregulated segments of the financial system as other entities such as hedge funds assume the risk.

[6]See the International Swaps and Derivatives Association–Securities Industry and Financial Markets Association (ISDA-SIFMA) July 2018 report on margins for noncleared derivatives. As a reference, most interest-rate swaps and credit-default swaps were required to be cleared by Title VII of the Dodd–Frank Act, which was implemented by the U.S. Securities and Exchange Commission (SEC) and

clients' collateral for the purpose of posting margins, while at the same time, the LCR constrains the dealers' ability to do so.

In addition to collateral transformation, dealers also offer maturity-transformation services. The LCR penalizes excessive maturity transformation, namely, the financing of more-than-30-day reverse repos through less-than-30-day repos. This penalty is negatively correlated with the collateral quality. Consistent with these incentives, we observe significant maturity transformation in excess of the 30-day threshold for high-quality collateral. For lower-quality collateral (corporate debt), foreign dealers subject to a less stringent LCR provide significant maturity transformation: They fund 47% of more-than-30-day reverse repos with overnight repos; on the other hand, this number is not significantly different from 0 for domestic dealers.

In the aftermath of the 2007–2009 financial crisis, several new banking regulations were introduced, including the Basel III leverage ratio and net stable funding ratio, the Volcker rule, and the U.S. stress tests. Although we cannot conclusively rule out the possibility that these other regulations may have affected our results, we argue in Section II.C that it is unlikely to be the case. On the other hand, our results are consistent with both LCR incentives and the timing of implementation.

There are also some liquidity risks that are not fully addressed by the LCR rule but are nonetheless present in the data. Maturity transformation within 30 days, although not always penalized by the LCR, can still expose dealers to rollover risk; this risk is present to various degrees across collateral types. For instance, in the Treasury and agency space, dealers finance half of their 2- to 30-day reverse repos with overnight repos. There is also some nontrivial degree of negative maturity transformation in the Treasury and agency space, which actually improves the LCR. However, it may expose dealers to the risk of collateral runs (Infante and Vardoulakis (2018)).[7]

To the best of our knowledge, this article is the first to study how dealers' business model (the joint management of assets and liabilities) has been affected by the LCR rule. This is especially important in light of the crucial role played by the dealers during the 2007–2009 crisis. To date, the only other article that empirically studies the effects of the LCR is that by Roberts, Sarkar, and Shachar (2018). Whereas we study the financial-stability implications for broker-dealers, they compare the behavior of large U.S. banks (subject to the LCR) to that of mid-size U.S. banks (not subject to the LCR). They find that LCR banks increase their HQLAs on the asset side and their insured deposits on the liability side, amounting to less liquidity creation. They also show that LCR banks provide fewer loans relative to non-LCR ones.

We contribute to the literature that studies changes in dealers' behavior after the 2007–2009 crisis, whether or not due to new regulations. Anbil and Senyuz (2018)

Commodity Futures Trading Commission (CFTC) in 2012 (see https://www.sec.gov/rules/final/2012/34-66868.pdf).

[7]A collateral run can happen when the collateral reversed in overnight is pledged in a longer-term repo, and the overnight reverse repo does not roll. In this instance, the client is effectively pulling the collateral away from the dealer while it is still pledged to another party; as a result, the dealer has to find another way of sourcing that collateral. These runs also erode the dealer's net financing.

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and Munyan (2017) use triparty repos to show the window-dressing behavior (deleveraging at month-end) of some foreign dealers in response to the Basel III leverage-ratio implementation. Other articles use the Trade Reporting and Compliance Engine (TRACE) database to focus on a specific aspect of dealers' activities, namely, providing liquidity in the corporate bond market. In particular, Adrian, Boyarchenko, and Shachar (2017), Anderson and Stulz (2017), Bao, O'Hara, and Zhou (2018), Bessembinder et al. (2018), Dick-Nielsen, Feldhütter, and Lando (2012), Goldstein and Hotchkiss (2020), Schultz (2017), and Trebbi and Xiao (2019) study corporate bond liquidity either after the 2007–2009 crisis or after the implementation of postcrisis regulations (Basel III and Volcker rule). These studies generally conclude that corporate bond liquidity has changed in nontrivial ways: Although measured bid–ask spreads are not very much affected, dealers tend to take less inventory risk by prearranging more and more trades, which can result in longer execution times. We complement these studies by showing that dealers rely much less on repos to finance corporate inventories after the 2007–2009 crisis, offering a basis for why they could be reluctant to take large inventories on their balance sheets.

II. Liquidity-Coverage Ratio

In this section, we review the LCR rule and the incentives it creates for broker-dealers. We also discuss the dimensions along which the U.S. implementation is more stringent than foreign ones: a less favorable treatment of corporate bonds, a maturity mismatch add-on, the use of daily average, and an earlier implementation. As part of the global response to the financial crisis, widely ranging regulatory requirements were introduced, addressing distinct risks to the global banking system. Among these reforms, the LCR was created to ensure that banks had sufficient available liquidity to withstand temporary disruptions to funding markets. The LCR applies to bank holding companies as well as any top-tier depository institution subsidiaries that have more than $10 billion in assets.

A. LCR Calculation

Quantifying liquidity resilience requires fixing a stress horizon over which assumed outflows occur. As such, the scope of the LCR is confined to a 30-day window and is intended to capture risks on both the asset and liability sides of a bank's balance sheet within this horizon. At its core, the LCR requires a sufficient stock of HQLAs to cover net cash outflows over a 30-day stressed period. More formally, the following ratio is expected to remain above 100%:[8]

$$\text{LCR} = \frac{\text{HQLA}}{\text{total 30-day net cash outflow}}. \tag{1}$$

[8]Note that for the U.S. LCR, there is a subcategory of depository institutions that are only subject to the "modified LCR," which is a simpler implementation and has a 0.7 factor applied to the denominator. These institutions typically exist within the range of $50–250 billion in assets (because anything over $250 in total consolidated assets is subject to the full LCR).

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According to the Basel Committee, HQLAs comprise three categories of eligible assets: Level 1 assets (0% haircut) count for 100% of their value and consist of cash, reserves, and securities fully guaranteed by a top-tier sovereign; Level 2A assets (15% haircut) count for 85% of their value and consist of agency mortgage-backed securities (MBSs), lower-grade sovereigns, and the upper portion of investment-grade (IG) corporate bonds (rated at least AA–); Level 2B assets (50% haircuts) count for 50% of their value and include equities listed in major indexes and the lower portion of IG corporate bonds (rated A+ to BBB–). Of note, although the European Union (EU) implementation follows these guidelines and allows the upper portion of IG debt to qualify as Level 2A assets and the lower portion as Level 2B (Grandia, Hänling, Lo Russo, and Åberg (2019)), the U.S. implementation is more stringent, allowing IG corporate bonds (rated at least BBB–) to qualify only as Level 2B assets.

Total Level 2 assets can make up no more than 40% of HQLAs, and 2B assets specifically cannot comprise more than 15%, ensuring that there is not a concentration of lower-quality assets. Net cash outflow (cash outflow minus cash inflow) is derived from a set of assumptions that are intended to simulate funding stress, resulting in an estimated net cash outflow over a 30-day period. The components within the denominator of the LCR cover a wide range of potential outflows, including deposits, repos, and commercial paper. For example, if a bank were to rely solely on very short-term and unstable funding (say 1-week commercial paper), this would be reflected in a significant net-cash-outflow value. There are a few important caveats. The first is that a bank cannot have a net cash outflow of 0 (a complete offset by inflows) because total inflows cannot exceed 75% of total outflows. Additionally, the U.S. implementation introduced a maturity mismatch add-on, which is added to the denominator of the ratio, defined as follows:

$$\max(0, \text{peak daily outflow in } 30-\text{day window}) - \max(0, \text{cumulative net outflow on day } 30).$$

This was introduced in the U.S. implementation with the intent of addressing the potential weakness in the LCR that would allow a major outflow to be only subsequently offset by an equivalent future (still within the 30-day window) inflow. The maturity mismatch add-on is therefore another dimension along which the U.S. implementation is more stringent than the foreign ones.

Most non-U.S. jurisdictions followed the initial Basel directive of computing the LCR using averages of *month-end* snapshots over the quarter. Instead, since Dec. 2011, U.S. regulators issued a proposed rule that would rely on *daily averages* over the quarter.[9] Therefore, U.S. banks need to satisfy the LCR rule on average each day, whereas most foreign banks have to satisfy the LCR only at month-end, leaving significant room for regulatory arbitrage (window dressing). Indeed, an Oct. 2019 European Central Bank (ECB) review finds that some European banks are window-dressing their LCR via collateral swaps and term deposits that improve the LCR only temporarily and mature right after the 30-day stress horizon is

[9]For the U.S. proposed LCR rule of Dec. 2011, see the Federal Register. The U.S. final LCR rule of Sept. 2014 is available at https://www.gpo.gov/fdsys/pkg/FR-2014-10-10/pdf/2014-22520.pdf.

recorded.[10] Not limited to the LCR, window dressing by foreign banks occurs in the context of the Basel III leverage ratio as well. Because month-end reporting also applies to most foreign implementations of the leverage ratio, Munyan (2017) and Anbil and Senyuz (2018) document that foreign banks take advantage of the month-end reporting by deleveraging at month-end, only to releverage the day after.

B. Timelines of the Regional Implementations

The Basel Committee introduced the LCR rule in Dec. 2010 and finalized it in Jan. 2013.[11] It also proposed a timeline for phasing in the LCR: The proposed gradual implementation would begin in Jan. 2015 with a minimum requirement set at 60%, increasing by 10% each subsequent year until it reached 100% in Jan. 2019. The effective implementation of the rule was delegated to the 28 jurisdictions that comprise the Basel Committee.

As jurisdictions implemented their own LCR rules, they also tailored their compliance timelines. Japan followed the Basel final-rule timeline. The EU phase-in more or less followed the dates set out in the Basel final rule: It finalized the rule in Jan. 2015, becoming 60% effective in Oct. 2015 and adding 10% at the beginning of each subsequent year, with a jump to 100% requirement in 2018, instead of 2019. As shown in Figure 1, the U.S. implementation was more accelerated: It was finalized in Sept. 2014, becoming 80% effective in Jan. 2015, with 10-percentage-point increases over the following 2 years and reaching 100% in Jan. 2017.[12]

Before July 2016, foreign banks operating in the United States were subject to their respective foreign implementations of the LCR. Afterward, U.S. regulators started to require foreign banks to form an intermediate holding company (IHC) that would comply with U.S. regulations. Therefore, for the purpose of identification, we exploit the fact that until July 2016, domestic dealers were subject to a more accelerated and stringent implementation than their foreign counterparts operating in the United States. Indeed, starting in Jan. 2015, domestic dealers were subject to an 80% LCR, whereas European ones were subject to a 60% LCR only starting in Oct. 2015. In Jan. 2016, domestic dealers were subject to a 90% LCR instead of 70% for European dealers operating in the United States. We end the sample in July 2016, when foreign dealers are required to start complying with the U.S. LCR implementation. Being subject to a quicker transition, U.S. banks faced a higher LCR requirement at each point in time during the implementation phase.

[10]See https://www.bankingsupervision.europa.eu/press/pr/date/2019/html/ssm.pr191007~842f68965f.en.html and, in particular, page 24 of the attached annex.

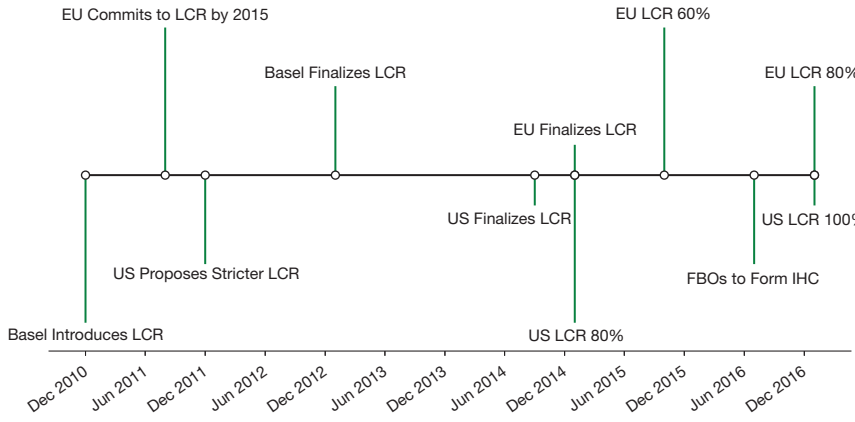
[11]The initial rule of Dec. 2010 is available at https://www.bis.org/publ/bcbs188.pdf. The final rule of Jan. 2013 can be found at https://www.bis.org/publ/bcbs238.pdf.

[12]Other jurisdictions that are relevant to our analysis are Japan, Switzerland, and the United Kingdom. The Japanese LCR was finalized in 2014 and became effective in Mar. 2015. The UK implementation was finalized in June of 2015, became effective in Oct. 2015, and then began following the EU timeline. The Swiss LCR was finalized in July 2014, became effective in Jan. 2015, and then began following the Basel timeline; however, the Swiss systemically important banks were required to be at full compliance starting in 2016. There are two such banks in our sample, not driving our results. Regional assessments by the Basel Committee are available at https://www.bis.org/bcbs/publications.htm.

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FIGURE 1
Timeline of the Main LCR Events

Figure 1 shows the main events surrounding the U.S. and EU implementations of the Liquidity Coverage Ratio (LCR).



Although the gradual phasing-in of the LCR was intended to ease the transition, many banks appear to have prepositioned significantly. As John Gerspach, Citigroup's chief financial officer (CFO) noted, "it's not that dissimilar from how we've really reacted to almost every regulatory rule that's been put out there over the course of the last six, seven years. We make sure that we get into compliance with that rule as quickly as possible. And then we approach optimization."[13] Because there was likely a significant anticipation effect between the announcement of the U.S. proposed rule in Dec. 2011 and its 80% phase-in date in Jan. 2015, we estimate dynamic adjustments to the LCR rule. In particular, we allow for anticipation effects (Dec. 2011 to Jan. 2015) as well as reoptimization effects (Jan. 2015 onward).

Although the Basel Committee introduced the LCR in Dec. 2010, each national regulator is responsible for its implementation in the respective jurisdiction. In July 2011, the European Commission issued a statement that only confirmed its intent to implement the LCR according to Basel's guidelines.[14] On the other hand, a few months later, in Dec. 2011, U.S. regulators issued a full and detailed proposal for the U.S. LCR, which already indicated stricter requirements relative to the Basel guidelines (see Figure 1). Therefore, the behavior of U.S. LCR dealers is likely to start diverging from that of foreign LCR dealers starting in Dec. 2011, when domestic banks are given concrete guidelines on how the regulation will be implemented.

Altogether, the following features of the U.S. implementation make the U.S. LCR more stringent than most foreign ones: a more accelerated transition; the requirement to comply on a daily basis, whereas foreign banks need to comply just at month-ends, allowing the latter to window-dress the LCR; a less favorable treatment of IG bonds; and the inclusion of a maturity-mismatch penalty, which is not present in foreign implementations. As an additional indication that the LCR is

[13]See the transcripts of Citi 2017Q2 fixed-income investor review.
[14]See https://www.ecb.europa.eu/ecb/legal/pdf/st13284.en11.pdf.

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more binding for U.S. banks than for foreign ones, the median LCR as of 2019Q3 for the domestic banks in our sample is 119, whereas that for foreign banks in our sample is 139.

C. Regulatory Incentives for Dealers

The LCR's impact on repo activity stems from the importance placed on both the tenor and collateral of a dealer's repo books. In the LCR rule, repurchase agreements expiring within 30 days are assumed to not roll at rates (runoff rates) in line with their collateral's HQLA haircut. For example, 0% of Treasury repos (secured by Level 1 assets) are assumed to run, even those with less-than-30-day maturity. On the other hand, 15% of repos secured by agency MBSs (Level 2A) and residual maturity of less than 30 days are assumed not to roll, leading to a cash outflow when the repo matures. Because a portion of the repos is assumed not to roll at maturity, some cash will be returned to the lender and collateral to the borrower. For the sake of simplicity, it can be boiled down to the distinction between repos that mature before and after the 30-day threshold: Only the former is assigned an outflow because the latter remain in place for the entire 30-day stress horizon. This translates to highly asymmetric LCR treatments of less-than-30-day and more-than-30-day repos because only the former are assumed to unwind in proportion to the assigned runoff rate. However, because a 31-day repo (that is not evergreen[15]) becomes a less-than-30-day repo in 1 day, it eventually contributes to the 30-day outflows measure.

Incentive to term out lower-quality repos. Given what we just said, the LCR incentivizes dealers to lengthen the maturity structure of their repos significantly beyond the 30-day threshold, everything else equal. This incentive is stronger for repos collateralized by lower-quality assets because these repos are attached to higher runoff rates once their residual maturity crosses the 30-day threshold. As a result, we expect dealers subject to a more stringent LCR (U.S. dealers) to increase the maturity of their lower-quality collateral repos by more in comparison to foreign dealers. The effect should be stronger for corporate repos, followed by agency repos, and absent in Treasury repos. We refer to this as *Hypothesis 1* (HP1).

Funding Treasuries internally to build the HQLA pool. The LCR incentivizes banks to rely less on repos to finance their inventories of high-quality assets. For an asset to count toward HQLA requirements, it needs to be unencumbered, namely, not pledged as collateral to a third party. Therefore, to the extent that a dealer needs to build up HQLAs, it is incentivized to finance its inventories of the highest-quality assets (Treasuries) less via the repo market and more using internal sources of cash. Suppose that a dealer needs to increase its HQLA pool by $1 million. The simplest way to do it is to use $1 million of internal cash to buy Treasuries, which fully count toward HQLA requirements and generate a higher yield than holding cash or reserves; purchasing any other asset would increase the stock of HQLAs less than proportionally. As a result, we expect dealers subject to a more stringent LCR to reduce the amount of high-quality collateral funded on the repo market. We call this *Hypothesis 2* (HP2).

[15]A 31-day evergreen repo is a repo contract that is renewed every day as a 31-day repo.

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Collateral upgrades to clients are penalized. Part of dealers' business model involves upgrading collateral for their clients, for instance, receiving low-quality collateral in exchange for Treasuries. Some clients use upgrades to obtain eligible (high-quality) collateral for margining of derivative trades at clearinghouses. If the collateral upgrade involves an exchange of clients' securities for the dealer's own securities, the dealer ends up lowering the quality of the securities in its possession. Alternatively, dealers can engage in economically similar trades for arbitrage purposes. For example, suppose that agency repos are trading at a considerable spread above Treasury repos. A dealer may take advantage of the spread by entering into an agency reverse repo funded by the cash raised through a Treasury repo. In either case, the dealer ends up taking possession of agencies in exchange for Treasuries, effectively downgrading its own collateral.

Providing collateral upgrades to clients is penalized by the LCR rule. For example, consider an overnight trade where the dealer obtains agency MBSs (Level 2A) in exchange for Treasuries (Level 1). The LCR rule assumes a runoff rate of 0 on the Treasury repo (100% expected to roll) and a 15% runoff rate for the agency MBS reverse repo (85% is assumed to roll). As a result, 100% of the Treasury collateral (Level 1) is locked out, whereas on the other side, 85% of the agency MBSs (Level 2A) is locked in, and only 15% of it comes back as cash (Level 1). In practice, the HQLA pool deteriorates by 13% (85% times 15%) of the value of the Treasuries provided. If the collateral was swapped for more than 30 days, the deterioration would be equal to 15% of the value. As a result, we expect dealers subject to a more stringer LCR to reduce the amount of high-quality collateral provided to clients in exchange for receiving lower-quality collateral. We call this *Hypothesis 3* (HP3).

Matched book is mostly LCR neutral. It is not necessarily the case that an overnight repo secured by Level 2 assets will deteriorate the LCR at the margin. Whether or not this is the case depends on how the collateral underlying the repo was obtained. If it is sourced through an overnight reverse repo, the symmetric application of runoff rates to both inflows and outflows renders this "matched-book" trade LCR neutral: Both outflows and inflows increase by the same amount, leaving net outflows unchanged.[16]

Excessive maturity transformation is penalized. On the other hand, if the same overnight repo secured by Level 2A assets serves the purpose of funding a more-than-30-day reverse repo, the LCR denominator would increase: The assumed outflow would equal 15% of the repo amount, whereas the inflow would be 0 because the reverse repo returns cash only after the 30-day threshold that matters for the LCR calculation. Therefore, intermediation of credit is penalized by the LCR to the extent that cash is raised via less-than-30-day repos and extended via

[16]The statement that matched-book trades are LCR neutral is an approximation. If a bank fully matches outflows and inflows so that net 30-day outflows are 0, the LCR still requires the bank to have HQLAs worth at least 25% of gross 30-day outflows. Under this scenario, an additional overnight matched-book trade with Level 2 collateral would deteriorate the LCR because it nevertheless increases gross 30-day outflows. On the other hand, matched-book trades can improve the LCR to the extent that reverse-repo haircuts are significantly larger than the associated repo haircuts. In this situation, the positive haircut differential generates extra HQLAs in the form of unencumbered rehypothecatable collateral (net financing).

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more-than-30-day reverse repos. This penalty does not apply if the collateral in question consists of Treasuries because a runoff rate of 0 is applied to Treasury repos of any maturity. Significant maturity transformation across the 30-day threshold in lower-quality assets is therefore costly under the LCR. As a result, we expect dealers subject to a more stringent LCR to reduce the amount of more-than-30-day reverse repos funded by less-than-30-day repos; the reduction should be stronger for lower-quality collateral. We call this *Hypothesis 4* (HP4).

D. Other Postcrisis Regulations

Our results are unlikely to be driven by other postcrisis regulations. As it relates to repo activity, the primary impact of the supplementary leverage ratio (SLR) is via a downward pressure on the volume of repos backed by the safest collateral (Duffie and Krishnamurthy (2016)). This is because it applies the cost of capital directly to all repurchase agreements, regardless of collateral type, making the lower-margin repo transactions the most eligible for reduction. Similar to the LCR, the SLR applies to domestic dealers on a daily basis, whereas it applies to most foreign dealers only at quarter-ends. Therefore, the main effect of the SLR is that foreign dealers reduce Treasury repo borrowings at quarter-ends (Munyan (2017), Anbil and Senyuz (2018)). No quarter-end deleveraging occurs in repos with lower-quality collateral.

The net stable funding ratio (NSFR) was designed by the Basel Committee to complement the LCR and requires banks to have enough stable and long-term liabilities to finance assets that require stable and long-term funding, where *long term* here refers to maturities greater than 1 year. As such, the NSFR would penalize the use of liabilities that mature in less than 1 year to finance assets maturing in more than 1 year. Because virtually all of the repos and reverse repos under consideration in our analysis have maturities of less than 1 year, the NSFR is very unlikely to affect our results. Moreover, as of the end of 2019, all of the jurisdictions included in our study had not yet implemented the NSFR.[17]

Additionally, the Volcker rule could have an impact on dealer inventories (Bao et al. (2018)) but not directly on banks' repo activity. This is due to the exemption of repos and reverse repos from consideration as proprietary trading, and therefore it is unlikely to have a material impact on dealers' repo activity. Moreover, the Volcker rule applies to the vast majority of the primary dealers in our sample and, in particular, to both domestic and foreign dealers.[18] Therefore, the U.S.-specific effects we estimate cannot be attributed to the Volcker rule because it also applies to the foreign dealers in our sample. In Tables A1 and A2 in the Appendix, we borrow the timeline and the list of dealers affected by the Volcker rule from Bao et al. (2018) and confirm that the Volcker rule had no significant effect on either the level or maturity structure of corporate repos. A timeline of the implementations of relevant postcrisis regulations is available in Table A3 in the Appendix.

[17]See the Financial Stability Board website at https://www.fsb.org/wp-content/uploads/P161019.pdf.

[18]Bao et al. (2018) lists in Table 7 the primary dealers affected and not affected by the Volcker rule. Two of the nonaffected are domestic, and two are foreign. The 17 affected dealers are split between foreign and domestic.

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Finally, U.S. stress tests are also unlikely to drive our results for two reasons: The primary effects have been on capital ratios, dividend payouts, and the composition of banks' loans portfolios (Acharya, Berger, and Roman (2018), Cortés, Demyanyk, Li, Loutskina, and Strahan (2020), and Bassett and Berrospide (2017)) and not the broker-dealer activities discussed in this article. Furthermore, U.S. stress tests affect both domestic and foreign bank holding companies; as such, they are unlikely to drive the differential (U.S.-specific) effects that we estimate.

III. Data

We use two confidential data sets. The first one contains triparty repo information that is sent daily by the two triparty clearing banks to the Federal Reserve Bank of New York (FRBNY) and becomes available in Jan. 2011. For each day and each repo borrower, we know the outstanding repo volumes broken down by residual maturity in days, as well as collateral type. The vast majority of repo borrowers by volume are the primary dealers, but other borrowers include commercial banks and large asset managers. Repo lenders are predominantly money market funds, other mutual funds, securities-lending agents reinvesting cash collateral, and sovereign wealth funds. For reasons related to data availability and similarities in business models (explained in more detail later in the article), we focus on the largest collateral types in fixed income, namely, Treasuries, agency MBSs, and corporate debt.

Summary statistics for the maturity structure of triparty repos are reported in Table 1. By comparing the maturity structure of domestic (Panel A) and foreign (Panel B) dealers subject to the LCR, it is apparent that domestic dealers significantly lengthen the maturity structure of lower-quality repos, namely, corporate repos, over time relative to foreign dealers. This pattern is confirmed in Graph B of Figure 2. The share of corporate repos with more-than-30-day maturities does not increase for domestic dealers until the announcement of the U.S. rule (first vertical line). Then, the domestic-LCR dealers (dashed line) start to increase the share of more-than-30-day corporate repos and reach a steady state before the U.S. rule becomes effective (second vertical line). Foreign-LCR dealers (solid line) do not significantly change their behavior after the first vertical line. Instead, they ramp up term repos only just before the second vertical line, which also corresponds to the EU rule being finalized (see Figure 1 for the timeline). On the other hand, the maturity structure of Treasury repos is not affected, as shown in both Table 1 and Graph A of Figure 2.

Our second data set is the FR 2004 Primary Government Securities Dealers Reports, from which we use primary dealers' positions and financing data (Forms A and C). Form A collects dealers' long and short positions in different types of securities, including Treasuries, agency MBSs, and corporate debt. The latter category consists of dollar-denominated debt securities issued by companies incorporated in the United States, including bonds, notes, commercial paper, privately placed securities, and private-label MBSs. We refer to the difference between a dealer's long and short positions in an asset class as *inventories*. Next, Form C collects financing transactions, where *financing* refers to the actual funds delivered or received and is divided into "Securities In" (funds are delivered, and collateral

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TABLE 1

Summary Statistics: Maturity of Triparty Repos

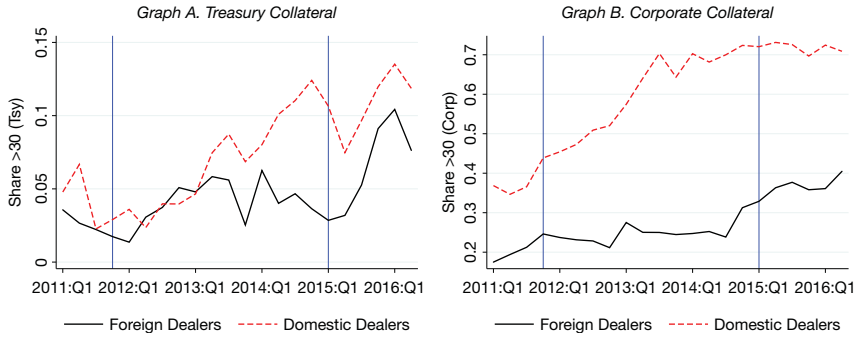
The sample in Table 1 goes from Jan. 2011 to June 2016. "Jan. 11–Nov. 11" refers to the time period until the U.S. implementation of the leverage-coverage ratio (LCR) is announced (Dec. 1, 2011); "Dec. 11–Dec. 14" is between the announcement of the U.S. implementation and when the U.S. LCR first becomes effective, namely, phased in at the 80% level (Jan. 1, 2015); finally, "Jan. 15–Jun. 16" is between the 80% phased-in date and when foreign dealers need to constitute a U.S. intermediate holding company subject to U.S. rules. "U.S. LCR" refers to the U.S. dealers subject to the U.S. implementation of the LCR; "Foreign LCR" refers to the foreign dealers subject to the various foreign implementations of the LCR. The variables represent the share of triparty repos backed by a certain collateral class that is maturing in a certain number of days. "TSY" refers to Treasuries, "AGY" to agency MBSs, and "CORP" to corporate debt. "OP" refers to open trades, "[1,30]" to maturities between 1 and 30 days (open trades excluded), "[31,90]" between 31 and 90 days, and "[>90]" to maturities beyond 90 days.

Time Periods	Jan. 11–Nov. 11		Dec. 11–Dec. 14		Jan. 15–Jun. 16	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A. U.S. LCR Dealers						
SHARE_TSY_OP	0.032	0.047	0.147	0.212	0.235	0.275
SHARE_TSY_[1,30]	0.925	0.090	0.784	0.256	0.656	0.289
SHARE_TSY_[31,90]	0.019	0.049	0.036	0.048	0.056	0.065
SHARE_TSY_[>90]	0.023	0.058	0.032	0.047	0.053	0.070
SHARE_AGY_OP	0.072	0.100	0.141	0.117	0.155	0.131
SHARE_AGY_[1,30]	0.785	0.185	0.667	0.182	0.566	0.263
SHARE_AGY_[31,90]	0.062	0.093	0.097	0.109	0.116	0.098
SHARE_AGY_[>90]	0.080	0.128	0.095	0.114	0.162	0.215
SHARE_CORP_OP	0.075	0.063	0.107	0.154	0.117	0.176
SHARE_CORP_[1,30]	0.556	0.270	0.285	0.241	0.164	0.173
SHARE_CORP_[31,90]	0.251	0.198	0.316	0.168	0.308	0.142
SHARE_CORP_[>90]	0.118	0.138	0.290	0.232	0.411	0.207
Panel B. Foreign LCR Dealers						
SHARE_TSY_OP	0.073	0.235	0.042	0.157	0.036	0.104
SHARE_TSY_[1,30]	0.901	0.247	0.916	0.208	0.901	0.195
SHARE_TSY_[31,90]	0.015	0.077	0.027	0.104	0.032	0.088
SHARE_TSY_[>90]	0.010	0.042	0.014	0.108	0.031	0.154
SHARE_AGY_OP	0.088	0.257	0.067	0.192	0.050	0.116
SHARE_AGY_[1,30]	0.786	0.312	0.765	0.285	0.811	0.255
SHARE_AGY_[31,90]	0.061	0.125	0.107	0.179	0.095	0.170
SHARE_AGY_[>90]	0.063	0.170	0.060	0.157	0.044	0.162
SHARE_CORP_OP	0.006	0.040	0.078	0.221	0.050	0.092
SHARE_CORP_[1,30]	0.793	0.254	0.672	0.336	0.585	0.327
SHARE_CORP_[31,90]	0.170	0.229	0.162	0.204	0.229	0.223
SHARE_CORP_[>90]	0.029	0.065	0.086	0.148	0.135	0.215

FIGURE 2

Share of Triparty Repos with More-Than-30-Day Maturities

In Figure 2, the *y*-axis shows the share of outstanding triparty repos with a maturity of greater than 30 days. Graphs A and B display dynamics in Treasury collateral and corporate debt collateral, respectively. The solid lines represent the average foreign dealer subject to the leverage-coverage ratio (LCR), whereas the dashed lines indicate the average domestic dealer subject to the LCR. The vertical lines represent the announcement of the U.S. implementation and the 80% phase-in of the U.S. rule, respectively.



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comes in) and "Securities Out" (funds are received, and collateral goes out). *Securities In* refers to agreements where securities are received, including reverse repos (dealer lends cash and receives a security as collateral) and securities borrowed (reporting the cash that is lent or the fair value of the securities if securities are exchanged or pledged as collateral). *Securities Out* similarly refers to agreements to deliver securities to counterparties, including repos (dealer borrows cash and delivers securities as collateral) and securities lent (reports the cash that is borrowed or the fair value of the securities if securities are exchanged or pledged as collateral).

The granularity of this data set evolves over time along three dimensions. First, financing transactions are collectively reported as Securities Out until Apr. 2013, when they start to be divided into repurchase and securities-lending transactions. To keep the data set comparable over time, after Apr. 2013, we add repos and securities lending together into Securities Out. Similarly, we add reverse repos and securities borrowing together into Securities In. Second, up until Apr. 2013, dealers have to distinguish between overnight and term financing only, whereas afterward, they are asked to separately report financing transactions with overnight, 2- to 30-day, and more-than-30-day maturities. Lastly, in Apr. 2013, private-label MBSs are removed from corporate debt collateral and added to a new category called "Other Debt," which also includes state and municipal debt. To keep the corporate debt collateral as comparable as possible over time, we effectively stop tracking private-label MBSs from the definition of corporate debt collateral, starting in Apr. 2013. There is a jump in corporate inventories and corporate repos around the Apr. 2013 change in classification of approximately 30%. We exclude the date when the classification changes from our estimation sample as a result of the discrete jump. Our results are robust to alternative classifications of corporate collateral after Apr. 2013.

Summary statistics are reported in Table 2. Panels A and B display repo and reverse-repo books, together with inventories of securities, broken down by collateral types and subperiods. Panel A refers to the U.S. dealers subject to the LCR, whereas Panel B reflects the activities of foreign dealers subject to the LCR. The very few primary dealers that are not subject to the LCR are excluded. Among the general decline in dealers' activities over time, Treasury inventories by U.S. dealers stand out for their increasing trajectory. Of note, the decline in corporate inventories over time is partly due to the change in classification of corporate debt securities across different vintages of data (see previous discussion). We can better gauge the generalized decline in corporate inventories from Panels C and D of Table 2, which display variables in first difference (weekly changes), dropping the dates on which the definition of corporate securities changes. As a result, we exclude discrete jumps due to the reclassification of corporate securities.

As previously noted, we focus our analysis on dealers' activities in fixed-income securities for several reasons. First, the LCR ranks them clearly from most to least preferred, namely, Treasuries, agencies, and corporate bonds, in that order. Second, dealers' business model is comparable among fixed-income securities, whereas it is quite different in equities. Indeed, on the market-making side, dealers intermediate the majority of trades in fixed income, whereas equity trades occur mostly on exchanges (Bessembinder, Spatt, and Venkataraman (2020)). A similar

TABLE 2

Summary Statistics: Financing and Inventories

The sample in Table 2 goes from Jan. 2004 to June 2016. "Jan. 04–Nov. 11" refers to the time period until the U.S. implementation of the leverage-coverage ratio (LCR) is announced (Dec. 1, 2011); "Dec. 11–Dec. 14" is between the announcement of the U.S. implementation and when the U.S. LCR first becomes effective, namely, phased in at the 80% level (Jan. 1, 2015); finally, "Jan. 15–Jun. 16" is between the 80% phased-in date and when foreign dealers need to constitute a U.S. intermediate holding company subject to the U.S. implementation. "U.S. LCR" refers to the U.S. dealers subject to the U.S. implementation of the LCR; "Foreign LCR" refers to the foreign dealers subject to the various foreign implementations of the LCR. Panels A and B display variables in levels, whereas Panels C and D display variables in first differences (weekly changes). SEC_OUT is Securities Out (dealer raises secured financing), SEC_IN is Securities In (dealer provides secured financing), and INV is Inventories (long minus short positions). "TSY" refers to Treasury collateral, "AGY" to agency mortgage-backed securities (MBSs), and "CORP" to corporate debt. All variables are expressed in $millions.

Time Periods	Jan. 04–Nov. 11		Dec. 11–Dec. 14		Jan. 15–Jun. 16	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A. U.S. LCR Dealers, in Levels						
SEC_OUT_TSY	130,340	46,033	119,495	49,940	108,345	49,432
SEC_IN_TSY	152,553	44,953	132,815	50,460	119,605	52,758
INV_TSY	−3,797	8,576	5,889	7,442	6,100	8,126
SEC_OUT_AGY	67,029	23,929	65,782	21,182	38,882	15,800
SEC_IN_AGY	43,984	16,317	40,360	14,337	21,742	9,221
INV_AGY	3,256	4,501	7,127	4,431	6,758	3,073
SEC_OUT_CORP	22,257	10,149	10,026	3,174	6,991	2,510
SEC_IN_CORP	10,930	5,376	6,605	2,428	5,437	1,542
INV_CORP	16,201	7,656	5,878	5,256	2,333	1,979
Panel B. Foreign LCR Dealers, in Levels						
SEC_OUT_TSY	94,085	72,346	77,103	60,049	65,501	49,365
SEC_IN_TSY	99,659	76,574	74,162	58,176	61,942	44,832
INV_TSY	−1,974	5,695	3,290	3,864	1,891	2,974
SEC_OUT_AGY	32,676	32,252	29,159	24,958	16,624	14,958
SEC_IN_AGY	18,211	18,542	18,518	15,222	10,129	7,922
INV_AGY	2,260	3,216	2,059	3,820	2,205	3,421
SEC_OUT_CORP	10,756	11,625	4,518	6,069	4,334	7,390
SEC_IN_CORP	7,025	7,424	3,779	5,030	3,969	6,978
INV_CORP	5,881	10,001	1,239	1,579	546	913
Panel C. U.S. LCR Dealers, in First Differences						
Δ SEC_OUT_TSY	212	9,077	−194	6,924	120	6,633
Δ SEC_IN_TSY	238	10,230	−213	7,237	259	6,807
Δ INV_TSY	11	3,268	−4	3,442	63	2,509
Δ SEC_OUT_AGY	81	5,782	−205	3,567	−63	1,893
Δ SEC_IN_AGY	52	5,475	−115	2,829	−87	1,473
Δ INV_AGY	43	1,461	−1	1,395	2	1,664
Δ SEC_OUT_CORP	−18	972	−5	562	−16	733
Δ SEC_IN_CORP	−2	566	2	401	−4	571
Δ INV_CORP	−34	1,386	−12	1,035	−11	920
Panel D. Foreign LCR Dealers, in First Differences						
Δ SEC_OUT_TSY	155	8,172	−126	6,144	56	5,362
Δ SEC_IN_TSY	153	8,505	−103	5,923	10	4,917
Δ INV_TSY	8	2,438	−23	2,034	41	1,451
Δ SEC_OUT_AGY	79	4,210	−96	3,520	−67	1,912
Δ SEC_IN_AGY	82	5,120	−50	3,411	−51	1,871
Δ INV_AGY	8	870	−3	750	−7	488
Δ SEC_OUT_CORP	10	818	−4	410	−7	356
Δ SEC_IN_CORP	11	368	1	196	−2	271
Δ INV_CORP	−5	500	−3	315	−1	341

divide between equities and fixed-income securities is also present in how dealers finance clients' positions. Following the stylized dealer balance sheet of Table 3, in the fixed-income space, dealers intermediate funding via repos and reverse repos. The credit provided to a client via reverse repos is funded by the dealer on the repo markets. In the equity space, dealers provide credit to their clients via margin loans. These loans are predominantly funded by other clients' short positions and, to a lesser extent, via repos (Macchiavelli and Pettit (2019)). The FR 2004 data contain neither dealers' margin loans nor clients' short positions, thus offering only a partial

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TABLE 3

A Stylized Broker-Dealer Balance Sheet

Table 3 is a stylized example of a broker-dealer's balance sheet. The main items on the asset side are reverse repos, securities borrowed, margin loans (the dealer provides cash loans to clients secured by collateral), inventories (the dealer's outright purchase of securities), and cash. On the liability side, the main items are repos, securities lent, customer shorts (similar to securities lent; the short position of a client generates cash), free credits (cash held in clients' margin accounts in excess of margin requirements), unsecured debt, and equity.

Assets	Liabilities
Reverse repos	Repos
Securities borrowed	Securities lent
Margin loans	Customer shorts
Inventories	Free credits
Cash	Unsecured debt
	Equity

view of the dealers' intermediation of credit in the equity space. In addition, the collection of equity financing only starts in 2013.

IV. Empirical Strategy and Results

A. LCR Effects on the Term Structure of Triparty Repos

The first hypothesis that we test is whether the LCR leads to a longer maturity structure (terming out) of repos with lower-quality collateral (HP1). We take advantage of the triparty repo data, which contains information on the maturity structure of triparty repos backed by different types of collateral. For the sample of triparty repo borrowers to be comparable, we keep only domestic and foreign dealers subject to the LCR. The non-LCR dealers are significantly smaller and much less involved in repo markets. We then exploit the fact that the U.S. implementation of the LCR, which applies to the domestic dealers, was stricter and quicker than the foreign implementations that apply to the foreign dealers. The additional stringency of the U.S. LCR was first communicated in the Dec. 2011 proposal of the U.S. rule and continued until the end of our sample. We use a difference-in-differences methodology and estimate the differential effect of the stricter U.S. LCR around the U.S. announcement and compliance dates (Dec. 2011 and Jan. 2015). In Jan. 2015, when the U.S. dealers must comply with an 80% LCR, most foreign dealers are not subject to the LCR yet. European dealers must comply with a 60% LCR only later in Oct. 2015. The sample ends in July 2016, a month before the foreign dealers in our sample need to form an IHC subject to the U.S. implementation. We run the following panel regressions:

$$\begin{aligned}(2)\qquad \text{SHARE}(M)_{i,c,t} = {} & \alpha + \beta_0 \text{PRE}_{-3} \times \text{US} + \beta_1 \text{PRE}_{-2} \times \text{US} \\ & + \beta_2 \text{POST} \times \text{US} + \mu_{i,c} + \mu_{t,c} + \varepsilon_{i,c,t}.\end{aligned}$$

The dependent variables are the shares of triparty repos outstanding on day t for borrower i at various maturities M (more than 30 days and more than 90 days), separately for each collateral type c (Treasuries, agency MBSs, and corporate debt). These collateral types represent the majority of triparty repo volumes. US equals 1 for the U.S. dealers subject to the U.S. LCR; the omitted group consists of foreign

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TABLE 4

LCR Effects on Triparty Repos

The sample in Table 4 goes from Jan. 3, 2011 (start of the triparty data), to June 15, 2016, and contains all the dealers (domestic and foreign) subject to the Basel leverage-coverage ratio (LCR) rule. $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise, and $POST_2$ equals 1 after the U.S. LCR is 80% phased in (Jan. 1, 2015), and 0 otherwise. "US" refers to the U.S. dealers subject to the U.S. LCR. Following Borusyak and Jaravel (2017), we evaluate the pre-trends in the second and third quarters of the pre-sample (PRE_{-3} and PRE_{-2}). Standard errors are 2-way clustered at the dealer and day level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	SHARE		SHARE		SHARE	
Tenor	>30	>90	>30	>90	>30	>90
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
Panel A. $POST_1$						
$PRE_{-3} \times US$	0.048	0.014	0.007	−0.015	−0.019	−0.005
	(0.029)	(0.022)	(0.023)	(0.040)	(0.034)	(0.019)
$PRE_{-2} \times US$	0.003	−0.019	−0.001	−0.005	−0.033	−0.005
	(0.020)	(0.012)	(0.029)	(0.035)	(0.024)	(0.016)
$POST_1 \times US$	0.030	0.005	0.014	0.016	0.137*	0.113**
	(0.020)	(0.019)	(0.040)	(0.029)	(0.072)	(0.045)
No. of obs.	34,204	34,204	34,989	34,989	28,652	28,652
Adj.R^2	0.358	0.296	0.614	0.510	0.709	0.659
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. $POST_1$ and $POST_2$						
$PRE_{-3} \times US$	0.048	0.014	0.007	−0.015	−0.019	−0.004
	(0.029)	(0.022)	(0.023)	(0.041)	(0.034)	(0.020)
$PRE_{-2} \times US$	0.003	−0.019	−0.001	−0.005	−0.033	−0.005
	(0.020)	(0.012)	(0.029)	(0.035)	(0.024)	(0.016)
$POST_1 \times US$	0.024	0.004	−0.020	−0.007	0.136**	0.092**
	(0.020)	(0.019)	(0.046)	(0.032)	(0.064)	(0.041)
$POST_2 \times US$	0.017	0.004	0.104*	0.070	0.005	0.066
	(0.029)	(0.023)	(0.057)	(0.056)	(0.067)	(0.073)
No. of obs.	34,204	34,204	34,989	34,989	28,652	28,652
Adj.R^2	0.358	0.296	0.621	0.516	0.709	0.662
Dealer FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of dealer clusters	30	30	32	32	28	28
No. of day clusters	1,238	1,238	1,238	1,238	1,238	1,238

dealers subject to foreign implementations of the LCR. POST is one of two dummy variables: $POST_1$ equals 1 after the announcement of the U.S. implementation of the LCR (Dec. 2011), and $POST_2$ equals 1 after the U.S. LCR is first phased in at the 80% level (Jan. 2015). To capture dynamic adjustments, in some specifications we use both time variations. The stand-alone terms (PRE, US, and POST) are not included because we use dealer and time fixed effects, $\mu_{i,c}$ and $\mu_{t,c}$ respectively. Errors are 2-way clustered at the borrower and day level.

We also check for parallel trends prior to Dec. 2011. Following Borusyak and Jaravel (2017), we divide the pre-sample in 4 quarters and pick the omitted categories to be the first and last quarters. We then evaluate the pre-trends in the second and third quarters of the pre-sample (called PRE_{-3} and PRE_{-2}). The parallel-trend assumption seems to hold in the data. In Table A4 in the Appendix, we also check for parallel trends several months prior to Dec. 2011, yielding the same lack of pre-trends result.

In Table 4, we show the effects of the LCR on the maturity structure of Treasury repos (columns 1 and 2), agency repos (columns 3 and 4), and corporate debt repos (columns 5 and 6). The maturity structure of Treasury repos is not

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affected by the LCR. Indeed, the LCR treats Treasury repos of any maturity as being as liquid as cash. On the other hand, we find some terming out of agency repos among domestic dealers. After the U.S. LCR is phased in at the 80% level, U.S. dealers increase the share of more-than-30-day agency repos by 10%, relative to foreign dealers. The moderate terming out of agency repos beyond the 30-day threshold is consistent with the fact that the LCR attaches a small runoff rate to less-than-30-day agency repos. Finally, columns 5 and 6 display a more sizable adjustment to the maturity structure of corporate repos. U.S. dealers significantly increase the share of corporate debt repos with a maturity of more than 30 days by 14%, and the share of more-than-90-day repos by 11%, relative to foreign dealers. The fact that we observe a more significant terming out of corporate repos relative to agency repos, and no significant terming out in Treasury repos, is in line with the fact that the LCR attaches a larger runoff rate to less-than-30-day corporate repos than less-than-30-day agency repos and none to Treasury repos (HP1).

These LCR effects on the maturity structure of repos are confirmed in Figure 2. Consistent with the fact that the LCR does not incentivize the terming-out Treasury repos, we do not see a clear difference in dynamics between domestic-LCR dealers (dashed line) and foreign-LCR dealers (solid line) after either announcement or implementation dates of the U.S. LCR. Also, the share of more-than-30-day Treasury repos is very small, at approximately 5% to 10%, and therefore the series are quite noisy. On the other hand, Panel B displays the dynamics of the share of corporate repos at more-than-30-day maturity. Domestic dealers maintain the share of term corporate repos stable until the announcement of the U.S. rule (first vertical line). Then, the domestic-LCR dealers start to increase the share of more-than-30-day corporate repos and reach a steady state before the U.S. rule becomes effective (second vertical line). Foreign-LCR dealers only increase term repos just before the second vertical line, which also corresponds to the EU rule being finalized.

The terming out of repos backed by lower-quality collateral has important financial-stability benefits. Dealers can rely on longer-term repos to finance less liquid inventories, which reduces fire-sale risk in a stress event. Relying on longer-term funding for corporate collateral also allows dealers to provide longer-term funding to their clients, which then benefit from less exposure to fire-sale risk as well.

B. LCR Effects on Financing and Intermediation of Securities

To determine the impact of the LCR on dealers' financing and intermediation, we use the confidential FR 2004 data, which contains information on primary dealers' secured assets and liabilities as well as their inventories of securities broken down by asset type at the weekly frequency. The primary dealers are the largest broker-dealers, and the vast majority of them are part of a bank holding company subject to the LCR. To tease out the effects of the LCR on dealers' financing and intermediation, we compare the domestic dealers subject to the more stringent LCR implementation to the foreign dealers around LCR announcement and compliance dates. We are interested in estimating how much dealers rely on secured funding to finance inventories, credit to clients, and collateral transformation and how those

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activities are affected by the LCR. To do so, we run the following set of panel regressions:

$$\begin{aligned}(3)\quad \Delta\text{SEC_OUT}i,c,t = {} & \alpha_0\Delta\text{INV}_{i,c,t} + \alpha_1\text{US}\times\Delta\text{INV}_{i,c,t} + \alpha_2\text{POST}\times\Delta\text{INV}_{i,c,t} \\ & + \alpha_3\text{POST}\times\text{US}\times\Delta\text{INV}_{i,c,t} + \beta_0\Delta\text{SEC_IN}_{i,c,t} \\ & + \beta_1\text{US}\times\Delta\text{SEC_IN}_{i,c,t} + \beta_2\text{POST}\times\Delta\text{SEC_IN}_{i,c,t} \\ & + \beta_3\text{POST}\times\text{US}\times\Delta\text{SEC_IN}_{i,c,t} + \mu_{i,c} + \mu_{c,t} + \varepsilon_{i,c,t}\end{aligned}$$

where $\Delta\text{SEC_OUT}_{i,c,t}$ is the weekly dollar change in collateral of type c (Treasuries, agency MBSs, or corporate debt) repoed out by dealer i during week t. $\Delta\text{INV}_{i,c,t}$ is the weekly change in the dollar value of inventories of type c securities. The collateral type of the inventories matches the collateral type of the securities going out because one way to finance inventories of securities is by repoing them out. $\Delta\text{SEC_IN}_{i,c,t}$ is a 3-by-1 vector, whose 3 elements are the weekly dollar change in Treasuries, agency MBSs, and corporate debt securities coming in. We allow for different collateral types coming in and going out to capture the extent to which dealers engage in collateral upgrades or downgrades for their clients. US is a dummy that identifies the domestic primary dealers subject to the LCR. Because we restrict our sample to the primary dealers subject to the LCR, the omitted group consists of the foreign primary dealers subject to foreign implementations of the LCR (mostly European and Japanese dealers). POST is one of two dummy variables: POST_1 equals 1 after the announcement of the U.S. implementation of the LCR (Dec. 1, 2011), and 0 otherwise, and POST_2 equals 1 after the U.S. LCR is first phased in (Jan. 1, 2015), and 0 otherwise. To capture dynamic adjustments and reoptimization, in some specifications we use both time variations. Finally, $\mu_{i,c}$ and $\mu_{c,t}$ are dealer and time fixed effects, respectively. Errors are 2-way clustered at the dealer and week level.

The coefficients α_3 and β_3 represent the effect of a more stringent LCR rule on dealers' activities. We start the sample in Aug. 2009, after the crisis-era liquidity facilities targeted to primary dealers were unwound, and we end it in July 2016, when most large foreign banks had to form an IHC for their U.S. operations to be subject to the U.S. implementation of the LCR. Table 5 displays the main results regarding the effects of the LCR on dealers' inventory financing and collateral transformation.

1. Financing Inventories

In addition to lengthening the maturity of lower-quality repos, which reduces the denominator of the LCR, dealers can improve the LCR by building up the stock of HQLAs, which increases its numerator. Dealers routinely hold inventories of high-quality assets as a way to make markets and provide liquidity to customers interested in buying and selling fixed-income securities. Significant numbers of these inventories are financed by dealers on the repo markets and are therefore pledged as collateral to a third party. In the LCR jargon, these pledged securities are encumbered and therefore do not count toward the stock of HQLAs. Indeed, for a security to count toward the HQLA pool, it has to be available to the dealer and ready to be monetized. Therefore, the LCR incentivizes dealers to reduce the

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TABLE 5

Adjustments in Financing and Intermediation to LCR Implementation

The sample in Table 5 goes from July 15, 2009 (end of liquidity programs), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR; $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise; and $POST_2$ equals 1 after the U.S. LCR is 80% phased in (Jan. 1, 2015), and 0 otherwise. Standard errors are 2-way clustered at the dealer (21) and week (360) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT		Δ SEC_OUT		Δ SEC_OUT	
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
	Financing Inventories					
$POST_1 \times US \times \Delta$ INV	0.027	0.007	−0.740*	−0.747*	−0.161	−0.171
	(0.085)	(0.125)	(0.413)	(0.412)	(0.101)	(0.107)
$POST_2 \times US \times \Delta$ INV	−0.279**	−0.279**	0.205	0.181	0.047	−0.055
	(0.105)	(0.108)	(0.162)	(0.174)	(0.144)	(0.163)
	Intermediation					
$POST_1 \times US \times \Delta$ SEC_IN_TSY	0.042	0.147	−0.078**	−0.099**	0.005	0.006
	(0.113)	(0.144)	(0.032)	(0.037)	(0.010)	(0.010)
$POST_2 \times US \times \Delta$ SEC_IN_TSY	0.008	−0.045	0.037	0.048	0.007	0.007
	(0.078)	(0.087)	(0.037)	(0.038)	(0.013)	(0.016)
$POST_1 \times US \times \Delta$ SEC_IN_AGY	−0.527***	−0.502***	0.156	0.161	0.008	0.005
	(0.132)	(0.145)	(0.153)	(0.143)	(0.006)	(0.010)
$POST_2 \times US \times \Delta$ SEC_IN_AGY	−0.131	−0.159	−0.252	−0.287	0.044	0.043
	(0.195)	(0.249)	(0.182)	(0.179)	(0.048)	(0.056)
$POST_1 \times US \times \Delta$ SEC_IN_CORP	0.742	1.050	0.359	0.575	0.210	0.164
	(0.731)	(0.817)	(0.371)	(0.464)	(0.226)	(0.251)
$POST_2 \times US \times \Delta$ SEC_IN_CORP	0.349	0.018	−0.174	−0.272	0.289*	0.293*
	(1.041)	(1.028)	(0.260)	(0.271)	(0.168)	(0.156)
No. of obs.	6,648	6,648	6,648	6,648	6,648	6,648
Adj. R^2	0.728	0.742	0.360	0.366	0.191	0.236
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
US × week FE	No	Yes	No	Yes	No	Yes

amount of Treasury securities being financed on the repo market, resulting in a greater amount being funded internally (HP2).

As shown in Table 5, the coefficient of $POST_2 \times US \times \Delta INV$ in columns 1 and 2 points to U.S. dealers significantly cutting their reliance on the repo market to finance Treasuries after the U.S. LCR is phased in at the 80% level. Relative to foreign dealers, U.S. dealers finance 28% less Treasury inventories on the repo market compared with pre-LCR compliance. This move is consistent with a tendency of U.S. dealers to finance high-quality assets with internal cash so that such Treasuries remain unencumbered and count toward HQLAs. A similar adjustment occurs in the financing of agency MBSs right after the U.S. LCR is announced. This adjustment is, however, only significant at the 10% level, suggesting some heterogeneity in the way U.S. dealers adjusted their financing of agency MBS inventories. In addition to the U.S. dealers increasing the fraction of Treasury inventories that are considered unencumbered, they also increase the average size of their Treasury inventories, as shown in Table 2. Both facts indicate that U.S. dealers are building up liquidity pools.

2. Intermediation and Collateral Upgrades

Prior to the introduction of the LCR, domestic dealers took advantage of the spread between agency MBSs and Treasury repos by reversing in agency MBSs

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while repoing out Treasuries; economically similar trades are also used by dealers to provide collateral upgrades to their clients.[19] However, this collateral-upgrade service becomes expensive from an LCR perspective because it involves delivering Level 1 assets in exchange for Level 2A assets (HP3).

In line with the penalty imposed by the LCR on collateral upgrades, Table 5 provides evidence that, indeed, U.S. dealers subject to the stricter LCR implementation significantly reduce the provision of collateral upgrades to clients. The coefficient of $POST_1 \times US \times \Delta SEC_IN_AGY$ in columns 1 and 2 is negative and statistically significant, suggesting that domestic dealers reduce the amount of collateral upgrades (delivering Treasuries to clients in exchange for receiving agencies) in the wake of the introduction of the LCR. In Table A5, the coefficient of $POST_1 \times US \times \Delta SEC_IN_AGY_ON$ in column 1 further indicates that the cutback in collateral upgrades occurred in the overnight space, involving the receipt of agencies at overnight or open tenor in exchange for the delivery of Treasuries at overnight or open tenor.

C. Endogenous De-Risking

Prior to the crisis, a significant amount of corporate debt inventories, including private-label MBSs, was financed overnight in the repo market (Macchiavelli (2019)), exposing dealers to significant rollover risk. The financing of illiquid assets with overnight repos proved to be unsustainable as the repo markets came under stress, forcing some dealers to sell, at fire-sale prices, the illiquid assets they could no longer finance. The Basel Committee designed the LCR in part to prevent this situation from happening again in the future. As discussed in Section A.1 of the Appendix, the LCR indeed penalizes the use of overnight repos to finance lower-quality assets. In this section, we ask whether dealers kept financing illiquid assets with overnight repos (as they did precrisis) until new regulations imposed explicit penalties.

A preliminary look at aggregate data suggests otherwise. Figure 3 shows how, in the run-up to the crisis, the growth in corporate inventories was financed by dealers on the repo markets, mostly with overnight tenors (not shown). The 2007–2009 crisis manifested itself in a massive deleveraging, with corporate inventories (black line) and funding secured by corporate collateral (gray line) plummeting. Coming out of the crisis, and definitely prior to Basel III regulations, dealers carried less corporate inventories and, as we will see next, relied much less on repo markets to finance them. Additionally, issuance of private-label residential MBSs, which made up a significant portion of corporate inventories precrisis, almost disappeared by 2009 (Goodman (2016)). The figure suggests that the crisis exposed several vulnerabilities in the business models of the dealers, leading to a reassessment of some of the risks.

The regression analysis of Table 6 confirms that most of the reduction in rollover risk occurred after the crisis and prior to the introduction of the LCR. We purposefully drop from the analysis the crisis period between Aug. 2007, when

[19]Evidence that, prior to the LCR, domestic dealers are reversing in agencies and repoing out Treasuries is presented in Table A7 in the Appendix. Specifically, the coefficient of $US \times \Delta SEC_IN_AGY$ in columns 1 and 2 is positive and statistically significant.

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FIGURE 3

Inventories and Secured Funding of Corporate Debt around the Crisis

Figure 3 shows aggregate data across all primary dealers taken from the Federal Reserve Bank of New York website (https://www.newyorkfed.org/markets/gsds/search). Displayed are Inventories (blue), Securities In (red), and Securities Out (green) pertaining to corporate debt collateral.

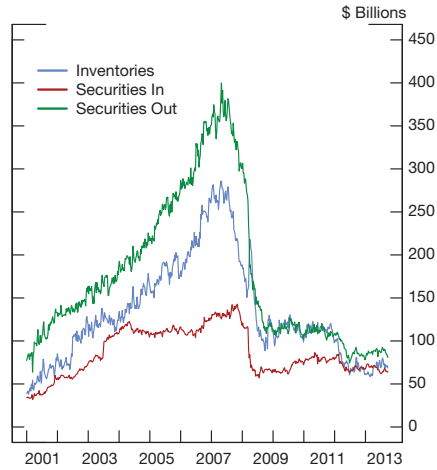


TABLE 6

Regulation or Self-Correction? Precrisis, Postcrisis, and Post-LCR

The sample in Table 6 goes from Jan. 7, 2004, to June 15, 2016, excluding the crisis period (Aug. 1, 2007, to July 15, 2009) and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR. POST_CRISIS equals 1 after the Federal Reserve liquidity programs for primary dealers are unwound (July 15, 2009), and 0 otherwise, and POST_LCR equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise. Observations in which the dealer is nonoperating in the respective collateral type are dropped. Standard errors are 2-way clustered at the dealer (22) and week (545) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT		Δ SEC_OUT		Δ SEC_OUT	
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
Δ INV	0.556***	0.541***	−0.105	−0.131	0.095**	0.102***
	(0.051)	(0.053)	(0.078)	(0.078)	(0.034)	(0.033)
US × Δ INV	0.032	0.047	−0.100	−0.092	0.340***	0.315***
	(0.089)	(0.095)	(0.150)	(0.144)	(0.087)	(0.078)
POST_CRISIS × Δ INV	−0.229***	−0.253***	−0.165	−0.073	0.056	0.053
	(0.060)	(0.067)	(0.190)	(0.194)	(0.108)	(0.111)
POST_CRISIS × US × Δ INV	−0.011	0.032	0.512**	0.473**	−0.392***	−0.379***
	(0.105)	(0.118)	(0.207)	(0.225)	(0.130)	(0.126)
POST_LCR × Δ INV	0.032	0.056	0.318	0.261	0.178***	0.193***
	(0.053)	(0.048)	(0.269)	(0.270)	(0.053)	(0.061)
POST_LCR × US × Δ INV	−0.029	−0.051	−0.504	−0.487	−0.139	−0.183**
	(0.083)	(0.121)	(0.308)	(0.295)	(0.093)	(0.085)
No. of obs.	9,584	9,584	7,033	7,026	8,730	8,730
Adj. R^2	0.781	0.793	0.411	0.421	0.186	0.211
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
US × week FE	No	Yes	No	Yes	No	Yes
Δ SEC_IN controls	Yes	Yes	Yes	Yes	Yes	Yes

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BNP Paribas halts redemptions from three affiliated funds, to July 2009, when the Federal Reserve unwinds both of its liquidity programs to sustain the primary dealers. We are interested in the results of columns 5 and 6, which pertain to the corporate debt activities of the primary dealers subject to the LCR. The coefficients of ΔINV and US $\times$ ΔINV suggest that prior to the crisis, foreign dealers financed 10% of their corporate inventories on the repo markets, whereas domestic dealers financed 42% of them with repos. Domestic dealers took significantly more rollover risk, which ultimately exposed them to larger fire-sale losses. This business model collapsed with the crisis, as shown by the coefficient of POST_CRISIS $\times$ US $\times$ ΔINV. Indeed, right after the crisis, domestic dealers reduce the share of inventories funded on the repo market by 38 percentage points relative to the foreign dealers, which did not significantly change their behavior. In effect, domestic dealers went from financing 42% of corporate inventories to just 10% of them (more in line with the foreign dealers). Crucially, this change occurred after the crisis and before the introduction of the LCR.

The coefficients of POST_LCR $\times$ ΔINV and POST_LCR $\times$ US $\times$ ΔINV show the post-LCR adjustments. Foreign dealers increased their reliance on the repo market to fund corporate inventories while U.S. dealers kept their reliance on repos constant throughout the postcrisis period. The reduced reliance on repos for inventory financing attributable to the LCR is not always statistically significant, and its magnitude is smaller than the risk reduction that occurred prior to the LCR.[20]

D. Maturity Mismatch: Cash and Collateral Rollover Risk

As previously discussed, the LCR penalizes excessive maturity transformation, namely, the financing of more-than-30-day reverse repos with less-than-30-day repos for lower-quality collateral (HP4). In this section, we provide a sense of the extent to which dealers engage in maturity transformation across different collateral types. The more granular data set that breaks down securities in and out by overnight, 2- to 30-day, and more-than-30-day tenors is only available starting in 2013. As a result, instead of a fuller difference-in-differences analysis, we can only provide a snapshot of dealers' maturity transformation post-2013, as the LCR adjustments are already under way.

Tables 7–9 display the degree of maturity mismatch within each collateral type. The coefficients of ΔSEC_IN_ON, ΔSEC_IN_$[2,30]$, and ΔSEC_IN_ > 30 across columns 2–4 can be interpreted as an "input–output" matrix: The diagonal elements (in bold font) estimate how much of the securities reversed in at a certain

[20]The reader may be concerned that the LCR, by leading dealers to lengthen the maturity of their corporate repos, may also make them more reluctant to hold corporate inventories. However, dealers use not just overnight repos to finance inventories but also term repos. In case the corporate collateral pledged in a term repo is sold, the dealers can generally substitute the sold bond in the collateral pool with another conforming bond or another security of superior quality. We address this concern directly by estimating a difference-in-differences model with the log of corporate inventories as the dependent variable and the set of U.S. LCR and post-LCR dummies and their interactions as regressors. The results are shown in Table A6 of the Appendix. Although there is a drop in corporate inventories post-LCR, the additional effect attributable to the more stringent LCR is not significant. We therefore cannot conclude that the LCR brought about a significant decline in corporate inventories.

TABLE 7

Maturity Transformation within Treasuries (2013–2016)

The sample in Table 7 goes from Apr. 13, 2013 (beginning of more granular data), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-overage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR. Dealer-week pairs with no repo activity are dropped. ΔSEC_IN (OTH_COLLAT) controls for securities in backed by collateral other than Treasuries. Standard errors are 2-way clustered at the dealer (21) and week (167) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT			
Tenor	ALL	ON	[2,30]	>30
	1	2	3	4
	Financing Net Positions			
Δ INV	0.357***	0.402***	0.009	−0.059
	(0.049)	(0.075)	(0.054)	(0.057)
US × Δ INV	0.063	0.048	0.019	−0.004
	(0.119)	(0.144)	(0.059)	(0.065)
	Intermediation			
Δ SEC_IN	0.936***			
	(0.019)			
US × Δ SEC_IN	−0.072			
	(0.059)			
Δ SEC_IN_ON		**0.787***	0.105***	0.030***
		(0.027)	(0.034)	(0.008)
Δ SEC_IN_[2,30]		0.458***	**0.405***	0.083**
		(0.075)	(0.064)	(0.033)
Δ SEC_IN_ > 30		0.449***	0.104**	**0.430***
		(0.102)	(0.048)	(0.114)
US × Δ SEC_IN_ON		−0.086	−0.015	0.011
		(0.063)	(0.048)	(0.016)
US × Δ SEC_IN_[2,30]		−0.110	0.106	0.034
		(0.111)	(0.101)	(0.047)
US × Δ SEC_IN_ > 30		−0.126	0.222	−0.099
		(0.150)	(0.142)	(0.110)
No. of obs.	3,297	3,297	3,297	3,297
Adj. R^2	0.802	0.552	0.356	0.328
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes
US × week FE	Yes	Yes	Yes	Yes
Δ SEC_IN (OTH_COLLAT)	Yes	Yes	Yes	Yes

tenor are repoed out at the same tenor. For instance, Table 7 shows that 79% of overnight Treasury reverse repos are funded with overnight Treasury repos, 41% of Treasuries coming in with a 2- to 30-day maturity are repoed out at 2 to 30 days, and finally, 43% of Treasuries reversed in at tenors greater than 30 days are repoed out at more-than-30-day tenors. Therefore, large diagonal elements suggest a high degree of maturity matching in the intermediation of securities (similar to the idea of a matched book). On the other hand, off-diagonal elements suggest some degree of maturity mismatch. The interactions with the US dummy display the additional pass-throughs for the domestic dealers.

1. Cash Rollover Risk

The lower-triangular elements of the input–output matrix involve financing longer-term reverse repos with shorter-term repos, which leads to the standard rollover risk (called *cash rollover risk* to differentiate it from collateral rollover

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TABLE 8

Maturity Transformation Within Agency MBSs (2013–2016)

The sample in Table 8 goes from Apr. 13, 2013 (beginning of more granular data), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR. Dealer-week pairs with no repo activity are dropped. ΔSEC_IN(OTH_COLLAT) controls for securities in backed by collateral other than agency mortgage-backed securities (MBSs). Standard errors are 2-way clustered at the dealer (21) and week (167) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT			
Tenor	ALL	ON	[2,30]	>30
	1	2	3	4
	Financing Net Positions			
Δ INV	0.075	−0.063	0.077	0.061
	(0.094)	(0.087)	(0.074)	(0.071)
US × Δ INV	−0.109	0.044	−0.080	−0.071
	(0.096)	(0.098)	(0.081)	(0.073)
	Intermediation			
Δ SEC_IN	0.814***			
	(0.034)			
US × Δ SEC_IN	−0.093			
	(0.073)			
Δ SEC_IN_ON		**0.550*****	0.158***	0.082***
		(0.059)	(0.034)	(0.024)
Δ SEC_IN_[2,30]		0.467***	**0.260*****	0.135***
		(0.068)	(0.063)	(0.029)
Δ SEC_IN_ > 30		0.589***	0.107*	**0.211*****
		(0.081)	(0.061)	(0.057)
US × Δ SEC_IN_ON		−0.206*	0.010	0.051
		(0.113)	(0.099)	(0.055)
US × Δ SEC_IN_[2,30]		0.230	−0.201**	−0.052
		(0.186)	(0.072)	(0.046)
US × Δ SEC_IN_ > 30		−0.130	−0.165	0.179**
		(0.129)	(0.115)	(0.079)
No. of obs.	3,217	3,217	3,217	3,217
Adj. R^2	0.559	0.228	0.097	0.117
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes
US × week FE	Yes	Yes	Yes	Yes
Δ SEC_IN (OTH_COLLAT)	Yes	Yes	Yes	Yes

risk). Table 7 suggests that dealers take significant cash rollover risk in intermediating Treasuries. Indeed, as the coefficients of ΔSEC_IN_[2,30] and ΔSEC_IN_ > 30 in column 2 suggest, 45% of Treasuries reversed in with tenors greater than 2 days are repoed out (financed) overnight. In these cases, dealers provide a cash loan for several days in exchange for collateral and come up with the needed cash by repoing out the same collateral overnight, then rolling over the overnight repo until the reverse repo matures. This service provided by dealers to clients operates very smoothly in normal times but could lead to significant rollover risk during times of stress.

Table 8 replicates the same exercise for agency MBS collateral. Dealers take as much cash rollover risk in the agency MBS space as in the Treasury space. Noteworthy, the coefficient of ΔSEC_IN_ > 30 in column 2 indicates that approximately 60% of reverse repos maturing in more than 30 days are funded via overnight (or open) repos. Once again, although feasible in normal times, this strategy may expose dealers to significant risk in the event of a sudden credit crunch.

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TABLE 9

Maturity Transformation within Corporate Debt (2013–2016)

The sample in Table 9 goes from Apr. 13, 2013 (beginning of more granular data), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR. Dealer-week pairs with no repo activity are dropped. ΔSEC_IN(OTH_COLLAT) controls for securities in backed by collateral other than corporate debt. Standard errors are 2-way clustered at the dealer (20) and week (167) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT			
Tenor	ALL	ON	[2,30]	>30
	1	2	3	4
	Financing Net Positions			
ΔINV	0.413***	0.331***	0.035***	0.049
	(0.058)	(0.034)	(0.010)	(0.062)
US × Δ INV	−0.310***	−0.263***	−0.034**	−0.013
	(0.100)	(0.074)	(0.012)	(0.067)
	Intermediation			
Δ SEC_IN	0.833***			
	(0.157)			
US × Δ SEC_IN	−0.770***			
	(0.176)			
Δ SEC_IN_ON		**0.810***	0.042**	0.033
		(0.152)	(0.017)	(0.026)
Δ SEC_IN_[2,30]		0.298*	**0.170****	0.125
		(0.169)	(0.062)	(0.116)
Δ SEC_IN_ > 30		0.466***	0.063	**0.119**
		(0.148)	(0.039)	(0.089)
US × Δ SEC_IN_ON		−0.792***	−0.036*	0.003
		(0.162)	(0.019)	(0.040)
US × Δ SEC_IN_[2,30]		−0.118	−0.006	0.123
		(0.297)	(0.083)	(0.228)
US × ΔSEC_IN_ > 30		−0.560	−0.174	0.387
		(0.427)	(0.117)	(0.368)
No of obs.	2,953	2,953	2,953	2,953
Adj.R^2	0.296	0.195	0.014	0.042
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes
US × week FE	Yes	Yes	Yes	Yes
ΔSEC_IN (OTH_COLLAT)	Yes	Yes	Yes	Yes

Finally, Table 9 reproduces the analysis for corporate debt collateral. Similar to their behavior in Treasuries and agencies, foreign dealers take significant cash rollover risk: The coefficient of ΔSEC_IN_ > 30 in column 2 indicates that 47% of more-than-30-day reverse repos are funded with overnight repos. On the other hand, U.S. dealers do not significantly use overnight repos to finance longer-term reverse repos. This result is consistent with the fact that U.S. dealers rely on overnight repos for corporate collateral less than their foreign counterparts (Table 1).

Although the Basel LCR rule does not penalize maturity mismatch within the 30-day window, it is important to highlight that the significant amount of 2- to 30-day reverse repos funded overnight that we estimate still exposes dealers to rollover risk. The introduction of the maturity-mismatch add-on in the U.S. implementation partially addresses the concern that within the 30-day period, cash outflows may be front-loaded, whereas the associated cash inflows occur later.

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2. Collateral Rollover Risk

A different type of risk arises by reversing in collateral at short tenors while repoing it out at longer terms. With these trades, captured in the upper-triangular elements of the input–output matrices, collateral is locked in a term repo and needs to be sourced at a higher frequency by rolling over the associated reverse repo (or security borrowing trade used to reverse in the collateral). If the shorter-term reverse repo does not roll during the life of the longer-term repo, the dealer has to deliver the collateral back to the reverse-repo party while that collateral is still held by the repo lender. Therefore, the dealer has to borrow (or buy) the same collateral from a third party to deliver to the reverse-repo party for the remaining life of the repo, or else the dealer will fail to deliver the collateral and pay the fails charge until the collateral is delivered.

The collateral rollover risk associated with a potential run by reverse-repo counterparties could materialize in a stress scenario where clients of a troubled dealer demand their collateral back to potentially move their business to another dealer. There are some anecdotes of this happening to Lehman Brothers prior to its bankruptcy.[21]

Tables 7 and 8 show statistically significant, albeit moderate, collateral rollover risk in both the Treasury and agency MBS spaces. From Table 8, 16% of the agencies reversed in overnight are funded by repos at 2- to 30-day tenors (ΔSEC_IN_ON in column 3), whereas 8% of them are funded by repos at more-than-30-day tenors (ΔSEC_IN_ON in column 4). It is likely that these trades involve bilateral repos (or security lending) where the dealer's client is interested in borrowing a certain security for a few weeks, and the dealer reverses in the specific security overnight or via an open trade. Importantly, this 8% of overnight agency reverse repos funded by more-than-30-day repos is not penalized by the LCR rule. On the contrary, it improves the LCR. Indeed, on the repo side, 100% of the cash is locked in for more than 30 days, whereas on the reverse side, it is assumed that only 85% of the cash is locked out, leading to a net inflow over the 30-day horizon.

On the other hand, there is little or no collateral rollover risk in the corporate debt collateral space, as shown in Table 9. There is also no significant difference between U.S. and foreign dealers in terms of collateral rollover risk. Because these more granular data are not available prior to Apr. 2013, we cannot establish whether these types of cash and collateral rollover risks have been affected by the LCR rule. Instead we provide a snapshot once LCR adjustments were already under way.

It is worth emphasizing once again that excessive collateral rollover risk, namely, the funding of short-term reverse repos with longer-term repos, improves the LCR by reducing net outflows. However, it exposes the dealer to the risk that clients pull their collateral away from the dealer by not rolling over short-term reverse repos. In this case, the dealer has to find a way to source collateral,

[21] See the Reuters article at https://www.reuters.com/article/lehman-rumors-idUSN1033762820080710 from July 2008. See also Infante and Vardoulakis (2018) for a theory of collateral runs.

which can be difficult in a stress event where clients are running from a specific dealer.

V. Conclusion

Broker-dealers experienced severe runs on their liabilities during the 2007–2009 financial crisis, exposing several vulnerabilities in their funding structure as well as the inadequacy of their liquidity pools. Against this backdrop, the Basel Committee proposed the introduction of the LCR rule, which required banks to hold enough liquid assets to withstand a hypothetical 30-day run. In this article, we estimate changes in the behavior of large broker-dealers operating in U.S. fixed-income markets that are consistent with both the incentives and implementation timelines of the LCR. To identify the effects of the LCR, we compare the behavior of large domestic dealers subject to the stricter and accelerated U.S. implementation of the LCR to that of large foreign dealers subject to the less stringent foreign implementations. Both the foreign and domestic dealers under consideration are located and operate in the U.S. market. We deliver several new results.

The longer maturity of repos backed by lower-quality collateral improves stability by reducing dealers' exposure to rollover risk. Similarly, the buildup of unencumbered Treasury securities improves stability by increasing the liquidity pools that can be monetized in the face of runs. On the other hand, the reduction in collateral upgrades for clients has unclear implications. While making the regulated sector safer, it increases the risks borne by the nonregulated segments of the market. We also show that an important aspect of fragility largely disappeared in the aftermath of the crisis and before the introduction of the LCR. In the run-up to the crisis, U.S. dealers in particular financed a large portion of their illiquid inventories with overnight repos. This strategy exposed them to significant fire-sale losses. Suggesting some degree of market self-correction, U.S. dealers drastically reduce both the amount of illiquid inventories and the share of illiquid inventories funded on the repo market right after the crisis and before the introduction of postcrisis regulations.

There are also some liquidity risks that are not fully addressed by the LCR rule but are nonetheless present in the data. Maturity transformation within 30 days, although not always penalized by the LCR, can expose dealers to cash rollover risk. For instance, in the agency space, dealers finance about half of their 2- to 30-day reverse repos overnight. There is also some nontrivial degree of negative maturity transformation in the Treasury and agency space, which improves the LCR but exposes dealers to collateral rollover risk.

Appendix

A.1. Repo Financing of Lower-Quality Assets

The financing of securities with more-than-30-day repos is mostly LCR neutral. However, financing a security with less-than-30-day repos is penalized, with the exception of

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TABLE A1

Effects of the Volcker Rule on Corporate Debt Inventories

The sample in Table A1 goes from Jan. 1, 2014, to Jan. 1, 2016, and contains primary dealers, both domestic and foreign. ln(CORP_INV) is the natural logarithm of the dealer's net position in corporate debt, and ln(LONG + SHORT_CORP) is the natural logarithm of the dealer's gross position (long plus short) in corporate debt. Negative net positions are missing values in ln(CORP_INV). $POST_VLK_1$ equals 1 after the Volcker rule requires certain banks to soon report quantitative metrics to regulators (Apr. 1, 2014), and 0 otherwise, and $POST_VLK_2$ equals 1 after July 21, 2015, when the banks are required to be fully compliant, and 0 otherwise. "AFF" refers to the dealers subject to the Volcker rule, following the classification of Bao et al. (2018). Standard errors are 2-way clustered at the dealer (20) and week (105) level. *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

	ln(CORP_INV)			ln(LONG + SHORT_CORP)		
	1	2	3	4	5	6
$POST_VLK_1$	0.151		0.291	0.149		0.231
	(0.398)		(0.373)	(0.340)		(0.284)
$POST_VLK_2$		−0.545**	−0.587***		−0.280	−0.313
		(0.203)	(0.178)		(0.269)	(0.231)
$POST_VLK_1 \times AFF$	−0.472		−0.488	−0.350		−0.348
	(0.439)		(0.401)	(0.381)		(0.315)
$POST_VLK_2 \times AFF$		0.029	0.103		−0.066	−0.014
		(0.298)	(0.267)		(0.327)	(0.285)
No of obs.	1,901	1,901	1,901	1,949	1,949	1,949
Adj. R^2	0.885	0.895	0.896	0.914	0.918	0.919
Dealer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Treasury securities or any other Level 1 asset. Suppose that a Level 2B asset (with a 50% haircut or runoff rate) is funded with overnight repos. The LCR assumes that 50% of the repo does not roll, leading to an outflow equal to 50% of its value. The mirror image of the repo running is that 50% of the collateral is returned as an unencumbered asset, which counts toward the HQLA pool for 50% of its value (because it has a 50% haircut). The end result is that at the unwind of the repo, the LCR numerator increases by 25% (50% of 50%) of the transaction value, whereas the denominator increases by 50%. The marginal effect on the LCR is therefore negative.

A.2. Effects of the Volcker Rule on Corporate Repos and Inventories

As we discuss in the main text, the Volcker rule is unlikely to drive our results because our LCR estimates come from the differential behavior of large U.S. dealers relative to large foreign ones, whereas the Volcker rule applies to both large domestic and large foreign dealers. Nevertheless, we discuss the potential that our results may be affected by the implementation of the Volcker rule. To estimate the effects of the Volcker rule on corporate debt inventories and repos, we follow Bao et al. (2018) for the timeline of the implementation of the Volcker rule and the classification of affected and nonaffected dealers.

In Table A1 we explore the effect of the Volcker rule on corporate debt inventories. Because inventory data are only available in the FR 2004 reports, Table A1 uses the sample of primary dealers, four of which are not affected by the Volcker rule. Following Bao et al. (2018), we allow for an early effect and a later effect: $POST_VLK_1$ equals 1 after Apr. 1, 2014, when affected banks need to report quantitative metrics to regulators, and 0 otherwise; $POST_VLK_2$ equals 1 after July 21, 2015, when affected banks

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TABLE A2

Effects of the Volcker Rule on Triparty Corporate Repos

The sample in Table A2 goes from Jan. 1, 2014, to Jan. 1, 2016, and contains large dealers, both domestic and foreign. ln(CORP_RP) is the natural logarithm of outstanding triparty corporate debt repos. The other dependent variables are as defined in Table 1, pertaining to corporate debt collateral. $POST_VLK_1$ equals 1 after the Volcker rule requires certain banks to soon report quantitative metrics to regulators (Apr. 1, 2014), and 0 otherwise, and $POST_VLK_2$ equals 1 after July 21, 2015, when the banks are required to be fully compliant, and 0 otherwise. "AFF" refers to the dealers subject to the Volcker rule, following the classification of Bao et al. (2018). Standard errors are 2-way clustered at the dealer (28) and day (456) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	ln(CORP_RP)	SHARE_OP	SHARE_[1,30]	SHARE_>30	SHARE_>90
	1	2	3	4	5
$POST_VLK_1$	−0.078	−0.012	−0.025	0.037	0.017
	(0.143)	(0.008)	(0.022)	(0.022)	(0.013)
$POST_VLK_2$	−0.097	0.000	−0.025	0.025	0.003
	(0.146)	(0.005)	(0.050)	(0.049)	(0.040)
$POST_VLK_1 \times AFF$	0.181	−0.025	0.023	0.002	0.017
	(0.217)	(0.037)	(0.047)	(0.033)	(0.027)
$POST_VLK_2 \times AFF$	0.038	−0.000	0.006	−0.006	0.019
	(0.235)	(0.030)	(0.070)	(0.070)	(0.053)
No of obs.	12,147	12,147	12,147	12,147	12,147
Adj.R^2	0.928	0.633	0.840	0.865	0.849
Dealer fixed effects	Yes	Yes	Yes	Yes	Yes

are required to be fully compliant, and 0 otherwise. Columns 1–3 use the log of corporate inventories (long minus short positions) as the dependent variable, whereas columns 4–6 use the log of gross positions (long plus short) to reflect the fact that the Volcker rule's prop-trading restrictions may affect both the large long positions and the large short positions taken by the dealers. The gross positions measure is also more in line with the weekly capital commitment measure of Bessembinder et al. (2018). Even though there is a significant aggregate decline in inventories in the later part of the sample ($POST_VLK_2 < 0$ in columns 2 and 3), the additional effect for Volcker-affected dealers is negative but not statistically significant. Across specifications, we do not find a significant effect on inventories or gross positions attributable to the Volcker-affected dealers.[22]

In Table A2, we study the effect of the Volcker rule on triparty corporate repo volumes and maturities. Here, using the triparty repo data, we can include a few more non-Volcker-affected dealers relative to the sample of primary dealers. Primary dealers nevertheless comprise the vast majority of repo volumes. The results indicate that the Volcker rule has no significant effect on corporate repo volumes (column 1) and on the maturity structure of corporate repos (columns 2–5).

[22]This result is in line with the findings of Bessembinder et al. (2018). The results for the weekly capital commitments are the most comparable to ours because we use weekly inventories. In Bessembinder et al. (2018), columns 5 and 6 of Panel A in Table VII show that the largest drop in the relative capital commitments of banks versus nonbanks occurs from the postcrisis period going into the regulatory period, and a relatively smaller change occurs from the regulatory period going into the Volcker period.

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A.3. Additional Tables

TABLE A3

Timeline of Relevant Regulations

Date	Regulatory Event
Dec. 2010	Basel introduces LCR and SLR
Aug. 2011	EU commits to LCR by 2015
Dec. 2011	U.S. proposes stricter LCR
Jan. 2013	Basel finalizes LCR
Jan. 2014	Basel finalizes SLR
Apr. 2014	Volcker rule: report quantitative metrics
Sept. 2014	U.S. finalizes LCR
Jan. 2015	U.S. LCR at 80%
Jan. 2015	EU finalizes LCR
Jan. 2015	SLR public disclosure begins
July 2015	Volcker rule: full compliance
Oct. 2015	EU LCR at 60%
Jan. 2016	U.S. LCR 90%
Jan. 2016	EU LCR 70%
July 2016	Foreign banks to form IHC
Jan. 2017	U.S. LCR 100%
Jan. 2017	EU LCR 80%
Jan. 2018	SLR is binding
Jan. 2018	EU LCR 100%

TABLE A4

LCR Effects on Triparty Repos (Alternative Pre-Trends)

The sample in Table A4 goes from Jan. 3, 2011 (start of the triparty data), to June 15, 2016, and contains all the dealers (domestic and foreign) subject to the Basel leverage-coverage ratio (LCR) rule. $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise, and $POST_2$ equals 1 after the U.S. LCR is 80% phased in (Jan. 1, 2015), and 0 otherwise. "US" refers to the U.S. dealers subject to the U.S. LCR. $PRE_{-1m} \times US$, $PRE_{-2m} \times US$, and $PRE_{-3m} \times US$ equal 1 for the U.S. dealers in Nov., Oct., and Sept. 2011, respectively, and 0 otherwise; the Nov., Oct., and Sept. 2011 dummies are themselves not included because they are collinear with the day fixed effects (FE). Standard errors are 2-way clustered at the dealer and day level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	SHARE_>30	SHARE_>90	SHARE_>30	SHARE_>90	SHARE_>30	SHARE_>90
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
Panel A.POST$_1$						
$PRE_{-3m} \times US$	−0.006	−0.002	−0.036	−0.016	0.015	0.012
	(0.013)	(0.015)	(0.041)	(0.033)	(0.049)	(0.016)
$PRE_{-2m} \times US$	−0.022	−0.015	−0.014	−0.023	0.043	0.005
	(0.022)	(0.021)	(0.041)	(0.037)	(0.049)	(0.024)
$PRE_{-1m} \times US$	−0.014	−0.009	−0.011	−0.002	0.001	0.019
	(0.019)	(0.019)	(0.049)	(0.038)	(0.063)	(0.035)
$POST_1 \times US$	0.012	0.004	0.007	0.018	0.157*	0.119**
	(0.027)	(0.026)	(0.045)	(0.031)	(0.077)	(0.049)
No of obs.	34,204	34,204	34,989	34,989	28,652	28,652
Adj.R^2	0.357	0.296	0.614	0.510	0.709	0.659
Dealer FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Panel B.POST$_1$ and POST$_2$						
$PRE_{-3m} \times US$	−0.006	−0.002	−0.036	−0.016	0.015	0.012
	(0.013)	(0.015)	(0.041)	(0.033)	(0.049)	(0.016)
$PRE_{-2m} \times US$	−0.022	−0.015	−0.014	−0.023	0.043	0.005
	(0.022)	(0.021)	(0.041)	(0.037)	(0.049)	(0.024)
$PRE_{-1m} \times US$	−0.014	−0.009	−0.011	−0.002	0.001	0.019
	(0.019)	(0.019)	(0.049)	(0.038)	(0.063)	(0.035)
$POST_1 \times US$	0.006	0.003	−0.027	−0.005	0.156**	0.098**
	(0.029)	(0.028)	(0.051)	(0.033)	(0.070)	(0.047)

(continued on next page)

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TABLE A4 (continued)

LCR Effects on Triparty Repos (Alternative Pre-Trends)

	SHARE_>30	SHARE_>90	SHARE_>30	SHARE_>90	SHARE_>30	SHARE_>90
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
$POST_2 \times US$	0.017	0.004	0.104*	0.070	0.005	0.066
	(0.029)	(0.023)	(0.057)	(0.056)	(0.067)	(0.073)
No of obs.	34,204	34,204	34,989	34,989	28,652	28,652
Adj.R^2	0.357	0.296	0.621	0.516	0.709	0.662
Dealer FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of dealer clusters	30	30	32	32	28	28
No of day clusters	1,238	1,238	1,238	1,238	1,238	1,238

TABLE A5

LCR Effects on Intermediation (Overnight vs. Term)

The sample in Table A5 goes from July 15, 2009 (end of liquidity programs), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR, and $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011). Standard errors are 2-way clustered at the dealer (21) and week (360) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT		Δ SEC_OUT		Δ SEC_OUT	
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
Tenor	ON	TERM	ON	TERM	ON	TERM
	1	2	3	4	5	6
$POST_1 \times US \times \Delta$ SEC_IN_TSY_ON	0.100	0.098	−0.115**	0.011	0.011	−0.000
	(0.108)	(0.081)	(0.049)	(0.032)	(0.008)	(0.008)
$POST_1 \times US \times \Delta$ SEC_IN_TSY_TERM	−0.017	0.112	−0.059	0.029	−0.005	0.015*
	(0.177)	(0.128)	(0.076)	(0.049)	(0.010)	(0.008)
$POST_1 \times US \times \Delta$ SEC_IN_AGY_ON	−0.369***	−0.189	0.153	−0.043	0.020	0.001
	(0.119)	(0.142)	(0.112)	(0.103)	(0.014)	(0.012)
$POST_1 \times US \times \Delta$ SEC_IN_AGY_TERM	−0.330	0.135	0.413*	−0.151	−0.046	0.031
	(0.384)	(0.334)	(0.238)	(0.146)	(0.039)	(0.026)
$POST_1 \times US \times \Delta$ SEC_IN_CORP_ON	0.232	0.882	−0.057	−0.073	0.324	−0.160
	(1.386)	(1.050)	(0.500)	(0.413)	(0.189)	(0.117)
$POST_1 \times US \times \Delta$ SEC_IN_CORP_TERM	1.178	0.001	1.942	−0.822	0.548	0.545**
	(1.888)	(1.412)	(1.129)	(0.605)	(0.341)	(0.226)
No of obs.	6,648	6,648	6,648	6,648	6,648	6,648
Adj.R^2	0.464	0.496	0.207	0.128	0.200	0.195
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
US × week FE	Yes	Yes	Yes	Yes	Yes	Yes

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TABLE A6

LCR Effects on Corporate Debt Inventories

The sample in Table A6 goes from July 15, 2009 (end of liquidity programs), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. ln(CORP_INV) is the natural logarithm of the dealer's net position in corporate debt. Negative net positions are missing values in ln(CORP_INV). The results are similar if these missing values are replaced with 0s. "US" refers to the U.S. dealers subject to the U.S. LCR; $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise; and $POST_2$ equals 1 after the U.S. LCR is 80% phased in (Jan. 1, 2015), and 0 otherwise. Standard errors are 2-way clustered at the dealer (20) and week (360) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	ln(CORP_INV)		
	1	2	3
$POST_1$	−0.659***		−0.461**
	(0.228)		(0.199)
$POST_2$		−0.791**	−0.625*
		(0.327)	(0.310)
$POST_1 \times US$	−0.118		−0.175
	(0.298)		(0.254)
$POST_2 \times US$		0.073	0.186
		(0.406)	(0.371)
No of obs.	6,038	6,038	6,038
Adj.R^2	0.854	0.854	0.865
Dealer fixed effects	Yes	Yes	Yes

TABLE A7

LCR Effects on Financing and Intermediation of Securities

The sample in Table A7 goes from July 15, 2009 (end of liquidity programs), to June 15, 2016, and contains all the primary dealers subject to the Basel leverage-coverage ratio (LCR) rule. "US" refers to the U.S. dealers subject to the U.S. LCR, and $POST_1$ equals 1 after the U.S. implementation of the LCR is announced (Dec. 1, 2011), and 0 otherwise. Standard errors are 2-way clustered at the dealer (21) and week (360) level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Δ SEC_OUT		Δ SEC_OUT		Δ SEC_OUT	
Collateral	TREASURY		AGENCY_MBS		CORP_DEBT	
	1	2	3	4	5	6
	Financing Net Positions					
Δ INV	0.326***	0.288***	−0.438	−0.399	0.151	0.154
	(0.051)	(0.051)	(0.325)	(0.351)	(0.092)	(0.096)
US × Δ INV	0.021	0.079	0.593*	0.624	−0.051	−0.063
	(0.081)	(0.070)	(0.323)	(0.362)	(0.101)	(0.102)
$POST_1$ × Δ INV	0.032	0.056	0.458	0.418	0.180***	0.195***
	(0.053)	(0.048)	(0.373)	(0.394)	(0.053)	(0.060)
$POST_1$ × US × Δ INV	−0.029	−0.051	−0.682	−0.700	−0.140	−0.185**
	(0.082)	(0.121)	(0.397)	(0.409)	(0.093)	(0.084)
	Pre-LCR Intermediation					
Δ SEC_IN_TSY	0.869***	0.896***	0.051*	0.047*	0.002	0.003
	(0.049)	(0.041)	(0.028)	(0.026)	(0.003)	(0.003)
US × Δ SEC_IN_TSY	−0.312**	−0.403***	0.034	0.046	0.002	0.004
	(0.119)	(0.116)	(0.035)	(0.036)	(0.004)	(0.004)
Δ SEC_IN_AGY	−0.089***	−0.077***	0.373***	0.376***	0.009**	0.009**
	(0.025)	(0.021)	(0.121)	(0.117)	(0.004)	(0.004)
US × Δ SEC_IN_AGY	0.494***	0.440***	0.024	0.023	−0.012	−0.014
	(0.084)	(0.086)	(0.166)	(0.165)	(0.007)	(0.009)
Δ SEC_IN_CORP	0.381	0.483**	0.189	0.205	0.986***	0.988***
	(0.251)	(0.202)	(0.197)	(0.208)	(0.229)	(0.235)
US × Δ SEC_IN_CORP	−0.659*	−0.754	0.145	−0.015	−0.747***	−0.740***
	(0.382)	(0.446)	(0.359)	(0.449)	(0.208)	(0.227)

(continued on next page)

TABLE A7 (continued)

LCR Effects on Financing and Intermediation of Securities

Collateral	Δ SEC_OUT TREASURY		Δ SEC_OUT AGENCY_MBS		Δ SEC_OUT CORP_DEBT	
	1	2	3	4	5	6
	Financing Net Positions					
	Changes in Intermediation Post-LCR					
$POST_1 \times \Delta$ SEC_IN_TSY	0.052	0.024	−0.014	−0.009	−0.003	−0.004
	(0.045)	(0.036)	(0.017)	(0.018)	(0.003)	(0.004)
$POST_1 \times US \times \Delta$ SEC_IN_TSY	0.045	0.134	−0.069**	−0.087**	0.007	0.009
	(0.101)	(0.126)	(0.028)	(0.034)	(0.007)	(0.008)
$POST_1 \times \Delta$ SEC_IN_AGY	0.221***	0.202***	0.285***	0.280***	−0.004	−0.003
	(0.031)	(0.023)	(0.051)	(0.052)	(0.006)	(0.006)
$POST_1 \times US \times \Delta$ SEC_IN_AGY	−0.542***	−0.524***	0.120	0.122	0.015**	0.013
	(0.135)	(0.145)	(0.151)	(0.138)	(0.006)	(0.010)
$POST_1 \times \Delta$ SEC_IN_CORP	−0.486	−0.602	−0.391	−0.423	−0.181	−0.158
	(0.434)	(0.395)	(0.264)	(0.268)	(0.240)	(0.247)
$POST_1 \times US \times \Delta$ SEC_IN_CORP	0.918	1.060	0.287	0.455	0.370	0.323
	(0.546)	(0.620)	(0.340)	(0.443)	(0.221)	(0.241)
No of obs.	6,648	6,648	6,648	6,648	6,648	6,648
Adj.R^2	0.728	0.742	0.358	0.364	0.178	0.225
Dealer fixed effects (FE)	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes
US × Week FE	No	Yes	No	Yes	No	Yes

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