Intermediary Balance Sheet Constraints, Bond Mutual Funds' Strategies, and Bond Returns

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Abstract

We show that after the introduction of the leverage ratio constraints on bank-affiliated dealers, bond mutual funds have engaged in more liquidity provision in investment-grade corporate bonds, and their performance has benefited. However, the liquidity and returns of investment-grade corporate bonds have become more exposed to aggregate outflows from the bond mutual fund industry. This suggests that the inability of bond funds to purchase bonds exposed to leverage constraints impacts market functioning. We show that mutual funds' missing liquidity provision helps explain which bonds experienced more severe deterioration in liquidity and returns at the onset of the COVID-19 pandemic.

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Keywords: Bond mutual funds, Intermediary Constraints, Corporate Bonds, Liquidity, Leverage Ratio

1 Introduction

Due to prudential regulations implemented in response to the global financial crisis, banks have become reluctant to intermediate low-margin, balance-sheet-intensive trades in safe asset markets (Duffie 2018). The same regulations have also significantly decreased the propensity of bank-affiliated dealers to provide liquidity for corporate bonds (Bessembinder et al. 2018; Choi et al. 2023; Rapp and Waibel 2023). What remains unknown, however, is how unregulated market participants respond and how their performance is affected. Not only have the regulations changed trading frictions and opportunities for unregulated intermediaries, but how the unregulated intermediaries respond to these regulations may affect the functioning of the corporate bond market. To address these important questions, this paper explores the strategies and performance of bond mutual funds and the consequences of their behavior on bond returns and liquidity.

Mutual funds have become prominent players in the corporate bond market in the decade following the 2008 global financial crisis. Unlike other market participants, such as insurance companies, which typically buy bonds at issuance and hold them until maturity, mutual funds frequently trade both in response to changes in their assets under management and to create alpha for their investors. Consequently, regulatory constraints on bank-affiliated dealers that affect liquidity conditions could significantly impact mutual funds' strategies and performance. The sign of this impact, however, is ambiguous. On the one hand, lower liquidity in the bond market could decrease the returns of mutual funds if they demand liquidity. On the other hand, the constraints on bank-affiliated dealers could provide trading opportunities if mutual funds engage in liquidity provision. In this case, liquidity-supplying mutual funds could partially substitute regulated financial institutions in liquidity provision and possibly earn an alpha on their trades.

This paper shows that mutual funds that engage in liquidity provision have benefited from tighter regulatory constraints on bank-affiliated dealers. While mutual funds' behavior improves liquidity in the bond market on average, we show that it has also increased the extent to which bond returns and liquidity are exposed to aggregate outflows from the bond mutual fund industry, suggesting that tighter regulations may have made liquidity conditions in the bond market more fragile.

To explore how constraints on regulated financial institutions spill over to mutual funds, we study the consequences of Basel III leverage ratio requirements for mutual funds' strategies, trading behavior, and performance. While various regulations that were introduced in the aftermath of the global financial crisis could have similar effects, the design of the Basel III leverage ratio is unique because it increases the intermediation costs for investment-grade bonds rather than high-yield bonds and induces within-quarter variation in the intensity of the constraints. These features facilitate the empirical identification of the effects of the leverage ratio requirements compared to other regulations.

Specifically, as part of Basel III, the leverage ratio requirements mandate that banks maintain a minimum amount of capital against all on- and off-balance sheet exposures, irrespective of their risk. Because the leverage ratio constrains the size of bank-affiliated dealers' balance sheets, extensive bond inventories become costly, irrespective of bond credit ratings. Since bank-affiliated dealers were already subject to risk-based capital requirements, which disproportionately increase the cost of holding high-yield bonds, the leverage ratio requirements primarily create regulatory pressure on dealers' investment-grade holdings. The leverage ratio should, therefore, constrain dealers' willingness to hold and provide liquidity in investment-grade bonds.

Furthermore, the leverage ratio requirements become most binding at quarter-ends (Du et al. 2018), when bank-affiliated dealers sharply contract their corporate bond inventories (Rapp and Waibel 2023). Exploiting the intra-quarter timing of mutual funds' trades in bonds that we expect to be more or less affected by bank-affiliated dealers' leverage ratio constraints, we can identify the effects of the regulation on mutual funds' trading strategies. Along the same lines, we can explore how the intra-quarter performance of funds with different trading strategies varies to isolate the mechanism through which the leverage ratio requirements affect mutual funds' performance.

Since mutual funds' strategies differ significantly and only a subset of funds engage in liquidity provision, we start by constructing a proxy for mutual funds' strategies inspired by Anand et al. (2021). Trading strategies are strategic decisions that depend on investment objectives, legal restrictions, and investor clientele and consequently change little over time (Cella et al. 2013). Accordingly, we classify the extent to which a fund has a liquidity-demanding or supplying trading style based on the correlation of the fund's trades with dealers' inventory cycles in the past. From the dealers' point of view, a positive inventory cycle in a bond is a scenario in which the market sells and the dealers accumulate inventories. Thus, a mutual fund would demand liquidity if it tends to sell like the rest of the market, exerting additional pressure on the dealers' balance sheets.

We find that the leverage ratio constraints affect mutual funds' trading: Following the introduction of the leverage ratio requirements, at quarter-ends, liquidity-supplying (LS) funds appear to purchase bonds that are predominantly intermediated by dealers subject to the leverage ratio constraints (henceforth "constrained" bonds) and thus likely in need of liquidity supply. We do not detect any changes in the strategies of liquidity-demanding funds. Consistent with the idea that market-making in high-yield bonds was already constrained by risk-weighted capital requirements, we observe that LS funds' trading behavior changes only for investment-grade bonds. LS funds appear to provide liquidity in high-yield bonds throughout the sample period. Notably, the quarter-end purchases of constrained investment-grade bonds subsequently outperform other purchases of LS funds.

Thanks to their liquidity provision in constrained bonds, LS funds appear to outperform other funds after the introduction of the leverage ratio requirements. This outperformance is driven by investment-grade bond funds, that is, funds that invest to a larger extent in the bonds in which market making was negatively affected by the leverage ratio constraints. In addition, we show that the alpha of LS funds, after the introduction of the leverage ratio constraints, is entirely realized in the first month of each quarter. This is consistent with our finding that LS funds purchase undervalued bonds in the last month of each quarter when the constraints are most binding for bank-affiliated dealers. Importantly, while all LS funds appear to provide liquidity in investment-grade bonds, the performance of those affiliated with dealers subject to the leverage ratio constraint benefits significantly more. This suggests that mutual funds have partially substituted bank-affiliated dealers in their liquidity provision and complement banks that may transfer profits to their affiliated funds.

We also evaluate the aggregate implications of mutual funds' behavioral changes for the bond market. While adopting an LS trading style is a mutual fund's strategic decision, which changes little over time (Cella et al. 2013; Anand et al. 2021), the extent to which mutual funds can actually engage in liquidity provision depends on their previous performance and flows. Poorly performing mutual funds are more likely to face redemptions and, hence, less likely to buy bonds that require liquidity supply. As a result, in periods in which LS mutual funds experience poor performance and outflows, the probability that they engage in liquidity provision drops. Arguably, because of bond funds' missing liquidity provision during periods of widespread redemptions, the liquidity and returns of constrained investment-grade bonds have become more exposed to aggregate outflows from the bond mutual fund industry after the adoption of the leverage ratio constraints. Importantly, this effect is distinct from that of fire sales (see, e.g., Falato et al. (2021) and Giannetti and Jotikasthira (2024)) not only because we control for bonds' fire sales but also because conceptually the increased exposure of bonds to redemptions arises from LS funds' missing purchases (not sales).

We validate our conclusions regarding the effects of mutual funds' missing liquidity provision by considering cross-sectional differences in bond liquidity and returns during the onset of the COVID-19 pandemic. We show that when the shock hit the corporate bond market and bond mutual funds experienced unprecedented redemptions (Falato et al. 2021), liquidity conditions and bond returns deteriorated, especially for investment-grade bonds that, through dealers' inventories, were more exposed to the leverage ratio constraints. Since we control for flow-induced fire sales, this result suggests that bond mutual funds' missing liquidity provision impacted bond market conditions.

Overall, our results indicate that recent banking regulations have shifted profits from liquidity provision in the bond market, at least partly, to unregulated institutions. While mutual funds help alleviate dealers' regulatory pressures at quarter-ends by providing liquidity, relying on open-ended investment funds makes the corporate bond market more vulnerable to investor redemptions, as LS funds cannot buy bonds in need of liquidity during such events.

We contribute to a growing body of literature that documents the effects of prudential regulations introduced after the global financial crisis on the functioning of bond markets. Existing studies on the corporate bond market highlight how increased capital requirements and other related regulatory provisions, such as the Volcker Rule, decreased the affected dealers' market-making activities and ultimately bond liquidity, especially in periods of market stress (Adrian et al. 2017; Bessembinder et al. 2018; Bao et al. 2018; Dick-Nielsen and Rossi 2019; Allahrakha et al. 2019; Haselmann et al. 2022; Choi et al. 2023). While most studies focus on the effects of capital requirements and other "risk-based" regulations, Breckenfelder and Ivashina (2021) and Rapp and Waibel (2023) explore the impact of leverage ratio constraints on dealers' inventories and bond liquidity.

So far, the existing literature focuses on dealers' behavior and provides little evidence on how the same regulations may have indirectly affected unregulated market participants. Unregulated intermediaries, however, have been shown to engage in liquidity provision, especially in periods of market stress. For instance, insurance companies and hedge funds provided liquidity during the March 2020 bond market meltdown, primarily supporting the dealers with prior trading relationships (O'Hara et al. 2022; Kruttli et al. 2024). Not only does prior work not consider the spillover effects of the regulations affecting bank-affiliated dealers, but insurers and hedge funds have more stable liabilities than mutual funds and have therefore different investment horizons and strategies (Cella et al. 2013; Giannetti and Kahraman 2018; Chodorow-Reich et al. 2021; Coppola 2024; Huang et al. 2021). The nature of their liquidity provision and its effects on bond markets will also likely differ.

We also contribute to an emerging literature documenting the interlinkages between banks and non-bank financial intermediaries in other domains (Acharya et al. 2024). We are the first to explore the extent to which unregulated market participants with relatively fragile funding provide liquidity to dealers subject to regulatory constraints and to consider the effects of the leverage ratio constraints on mutual funds' trading and performance as well as bond liquidity and returns.

By focusing on the leverage ratio regulations, we also contribute to the growing literature that studies the distortions created by the leverage ratio constraints on fixed income and short-term money markets (Duffie 2018). Existing studies focus on parity deviations (Du et al. 2018; Cenedese et al. 2021), money market dislocations (dAvernas and Vandeweyer 2022; Correa et al. 2022; He et al. 2022), changes in the swap and treasury yield curves (Du et al. 2023; Jermann 2020; Klingler and Sundaresan 2023), and changes in the repo market structure and bank risk-taking (Allahrakha et al. 2018; Choi et al. 2020; Klingler and Syrstad 2021). To the best of our knowledge, we are the first to highlight that some unregulated market participants benefit from the dislocation caused by constraints on regulated financial intermediaries and that LS funds' missing liquidity may increase fragility in the corporate bond market during periods of aggregate outflows from bond mutual funds.

Finally, others have identified quarterly trading patterns of equity mutual funds aiming to window-dress portfolios at reporting dates to conceal holdings of losing stocks and overstate holdings of winning stocks (Lakonishok et al. 1991; He et al. 2004; Agarwal et al. 2014). Window-dressing behavior cannot explain the patterns we document for bond mutual funds' quarter-end trading because the effects emerge after the adoption of Basel III, while incentives to window-dress should be unchanged over the sample period. In addition, there is no reason to believe that incentives to window-dress should exist for investment-grade bonds but not high-yield bonds.

2 Changes in Regulatory Environment

Since the global financial crisis of 2007-2008, banks must comply with various regulations impacting their capital and liquidity requirements (Greenwood et al. 2017). These regulations have increased balance sheet costs for banks' market-making activities, potentially affecting clients, including bond mutual funds. While the main thrust of our analysis should extend to any regulations affecting bank-affiliated dealers' costs of liquidity provision, we focus our investigation on the leverage ratio constraint because, as we explain below, its design allows sharper identification of the effects on bank-affiliated dealers and, by extension, bond mutual funds. In addition, a better understanding of the effects of the leverage ratio regulation is particularly relevant as some argue that it caused a distortionary reduction in banks' incentives to intermediate safe assets without financial stability benefits (Duffie 2018).

Specifically, the implementation of Basel III and the subsequent introduction of non-risk-weighted capital requirements have raised the cost of balance sheet expansion for banks and their affiliated dealers. Because of these regulations, commonly referred to as the leverage ratio (supplementary leverage ratio in the United States), banks started reporting their leverage ratios to regulators in January 2013. Effects on financial markets have been found to coincide with the public disclosure of the leverage ratios in January 2015 (Du et al. 2018; Jermann 2020). Thus, even if compliance with the leverage ratio requirements became mandatory only in 2018, consistent with the literature, we consider 2015 as the starting point for the regulation. We show that the dynamic effects we uncover are consistent with this assumption. The leverage ratio requirements mandate that banks maintain a minimum amount of capital against all on-balance-sheet assets and off-balance-sheet exposures, regardless of risk. Hence, for the leverage ratio requirements, the size of the balance sheet matters rather than its riskiness.

In contrast, banks and their affiliated dealers have always been subject to risk-weighted capital requirements. Because the capital that a regulated institution has to set aside depends on the risk of its assets, the risk-weighted capital regulations increase banks' inventory costs for riskier bonds, thus constraining bank-affiliated dealers' liquidity provision in these bonds. Since the risk-weighted capital requirements were already in place, the newly introduced leverage ratio regulations have prompted intermediaries to primarily divest their holdings of safe assets (Duffie 2018), such as repo and government securities, and have reduced bank-affiliated dealers' propensity to hold inventories of investment-grade corporate bonds relative to high-yield bonds (Rapp and Waibel 2023). Thus, we expect the leverage ratio to change mutual funds' trading behavior and performance in investment-grade bonds but not in high-yield bonds.

Moreover, although the leverage ratio requirements vary across jurisdictions due to preexisting regulatory frameworks, the incremental regulatory burden at quarter-ends, compared to prior regulations, has intensified for all impacted financial institutions. Historically, U.S. banks operated under non-risk-weighted capital requirements, which appeared to exert limited influence before Basel III (Du et al. 2018). The regulatory landscape shifted for systemically important financial institutions with the inception of the supplementary leverage ratio, which rendered the leverage ratio constraint more stringent. Although U.S. systemically important financial institutions' leverage ratio is calculated as an average over the quarter, compliance with the constraint is obligatory by the end of each quarter when the constraint becomes binding. Conversely, for international banks, the non-risk-weighted capital requirements were newly introduced after the global financial crisis and calculated based on the leverage ratio at the end of each quarter. This implementation of the regulation changed in 2017 for U.K. banks, for which the leverage ratio requirement started to be averaged over the quarter, as for U.S. banks.

Importantly, following the introduction of the leverage ratio constraint, irrespective of whether regulators consider the average over the quarter or just the quarter end, all bank-affiliated dealers subject to the Basel III regulations appear to contract their investment-grade bond inventories at quarter ends (Rapp and Waibel 2023). The leverage ratio constraint thus appears to be binding for bank-affiliated dealers at quarter ends. Overall, the dealers subject to the leverage ratio regulations constitute a significant part of the market and can, therefore, affect bond market conditions.

As we explain below, in our empirical analysis, we exploit the fact that the regulation becomes more stringent at quarter ends to identify the effects of the leverage ratio constraints on mutual funds' strategies and performance. Specifically, our identification relies on the within-quarter timing of mutual funds' trades and portfolio performance, combined with the cross-sectional variation in the extent to which recent bond market makers are affected by the leverage ratio constraints. Besides using within-quarter variation, in supplementary tests, we also consider that bank-affiliated dealers have different capitalization levels, and their leverage ratio constraint may be more or less binding. Finally, we expect any effects of the leverage ratio requirements to emerge only for investment-grade bonds, not high-yield bonds.

While several overlapping regulations were introduced after the global financial crisis, other banking regulations do not produce the same within-quarter variation and are unlikely to affect investment-grade bonds more than high-yield bonds. For instance, risk-weighted capital requirements were already present before 2015 and, more importantly, are expected to disproportionately affect inventories of the riskier high-yield bonds, not investment-grade bonds. The additional capital requirements for globally systemically important banks (G-SIBs), known as G-SIB surcharges, the Volcker Rule, and the liquidity directives partly overlap with the introduction of the leverage ratio. However, the G-SIB surcharges, which also increase the cost of balance sheet space for institutions whose holding companies have been identified as G-SIB, are binding only at year-end. As we will show, our results are invariant to the exclusion of the last quarter of a year. The Volcker rule restricts banking entities from engaging in proprietary trading and impacts dealers' cost of intermediation because higher values of bond inventories may indicate proprietary trading. However, the Volcker rule does not become binding at quarter ends, and there is no reason to believe that it should have stronger effects on investment-grade bonds. Finally, the liquidity coverage ratio (LCR) aims to ensure that a bank has enough liquid assets and the net stable funding ratio (NSFR) that banks have reliable funding sources in a stressed environment. Thus, the NSFR addresses the liability side of the balance sheet and should be irrelevant for market making. The LCR addresses the asset side of the balance sheet and impacts intraday liquidity. Furthermore, contrary to the leverage ratio, the LCR is ameliorated by holdings of liquid investment-grade bonds and should, therefore, incentivize banks to retain the more liquid investment-grade bonds over high-yield bonds.

3 Data and Main Variables

We obtain data on bond mutual fund holdings from Morningstar, data on mutual fund characteristics from Morningstar Direct and the CRSP Mutual Funds database, data on bond characteristics from Mergent's Fixed Income Securities Database (FISD), and data on corporate bond transactions with dealers' identities from the regulatory version of FINRA's Trade Reporting and Compliance Engine (TRACE) database.[1] Our primary sample spans from 1/2010 to 12/2019, but we complement these analyses with an investigation of the period surrounding the onset of the COVID-19 pandemic. Detailed variable definitions can be found in the Appendix.

3.1 The Mutual Fund Sample

We focus on open-end mutual funds classified by Morningstar as taxable bond funds. There are a total of 2,310 unique funds, but given our focus on the corporate bond market, our main analysis includes only 1,167 funds, for which corporate bonds are at least 20% of the portfolio holdings (of these, 61% invest mostly in investment-grade bonds while 39% invest mostly in high-yield bonds). Using Morningstar along with Morningstar Direct and CRSP, we construct a survivorship-bias-free dataset that includes information on various fund characteristics, such as TNA, returns, flows, and fund-level bond holdings. The frequency of TNA, returns, and flows is monthly, and so are our estimated alphas. While the SEC requires mutual funds to report holdings on a quarterly basis, funds tend to voluntarily report their holdings more frequently. Approximately 83% of our sample's fund reporting-period observations are monthly, while the remaining are quarterly. We condition on the available frequency in measuring trading styles, while our tests on mutual funds' trading rely only on funds that report monthly.

[1]TRACE does not include identifiers for customers and therefore does not allow to identify mutual funds' trades.

3.2 Classifying Funds' Strategies

Funds' trading styles, including the decision to supply or demand liquidity, reflect long-term strategic decisions, which involve the choice of investment objectives as well as legal restrictions, funding conditions, and investor clientele (Anand et al. 2021).

Theoretically, a fund can be considered liquidity-supplying if it buys bonds in which dealers' cumulative inventories are larger than desired. Similarly, a liquidity-supplying fund would sell when the aggregate dealer sector's inventories fall below the desired level. To implement this intuition empirically, we follow Anand et al. (2021). Specifically, using transaction data from the regulatory version of TRACE, we compute, on each trading day, the inventory change in a given bond for an individual dealer and then aggregate the inventory changes across all dealers to obtain a measure of the change in the dealer sector's inventory in the bond.[2]

The aggregate inventory of the dealer sector may be considered above (below) the desired level if the change in inventory in a given bond is positive (negative) when cumulated over several trading days. We assume that the cycle starts when the cumulative inventory crosses zero and ends when it crosses zero again from the opposite direction. Like Anand et al. (2021), we restrict our attention to significant trading cycles by imposing a minimum peak inventory of $10 million and a minimum inventory cycle length of 5 calendar days. In addition, to minimize errors, when the cumulative inventory in a given bond does not cross zero for a period longer than 3 months (63 trading days), we drop older inventories and instead define the dealer sector's aggregate inventories in the bond over a rolling window of three months. Our inventory cycles last about 62 days on average, with 59% being positive and 41% being negative. The average peak inventory is $29 million.

These inventory cycles are likely to capture customers' buying and selling imbalances. By considering the trading behavior of mutual funds over the cycles, we can gauge their trading strategies. A fund supplies liquidity by purchasing bonds that are experiencing a positive inventory cycle and selling bonds in a negative inventory cycle. Similarly, a fund demands liquidity if it sells bonds experiencing a positive inventory cycle and buys bonds in a negative inventory cycle. To the extent that not all bonds are in a cycle, each fund will also have unclassified trades.

[2] We consider only principal trades (not agency trades) to compute dealer inventory changes.

The fund's trading style is summarized by the fund's liquidity score, *LS score*, which is computed for fund i and period t as:

$$LS\ score = \frac{Liquidity\ supplied\,(\$) - Liquidity\ demanded\,(\$)}{Liquidity\ supplied\,(\$) + Liquidity\ demanded\,(\$) + Unclassified\,(\$)}. \tag{1}$$

We infer the transactions of a bond mutual fund by comparing the fund's holdings in a bond over consecutive reporting periods. Because in our sample, 83% of the funds' positions are reported monthly and the remaining quarterly, the period can be either a month or a quarter.

Since fund strategies should not vary much over time, but at the same time, we want to capture the effects of regulations on funds' strategies, we define funds' strategies over a rolling window of 24 months. In most of the empirical analysis, we classify funds with a positive rolling average *LS score* during the previous 24 months as liquidity-supplying (LS) and all remaining funds as liquidity-demanding (non-LS). With this classification, about a quarter of the sample funds are characterized as LS, with a small increase from 24% in 2010 to 27% in 2019.

3.3 Mutual Funds' Characteristics

Table 1, Panel A reports descriptive statistics for various fund attributes, with the first five columns highlighting the full sample (58,040 fund-reporting period observations) and the last two columns comparing the means for LS and non-LS funds. The distribution of fund TNA is positively skewed, with a mean of about $2.52 billion and a median of only $0.54 billion. Consistent with the growth in bond mutual funds documented by Goldstein et al. (2017), our sample funds experience significant inflows. The average monthly fund flow is 0.7% of TNA, with the 10th and 90th percentiles at -3.1% and 5.1%, respectively, indicating significant variation across funds and over time.

During our sample period, LS funds appear to be significantly larger than other funds and experience 0.71% higher net flows and 2 basis points higher alpha, suggesting that they might have benefited from the change in the regulatory environment.[3]

[3]The LS funds in our sample have somewhat different characteristics from those in Anand et al. (2021) because we focus on the period around the introduction of the leverage-ratio regulation. We thus start our

The average fund in our sample holds 8% in cash and cash equivalents, with LS funds holding significantly more cash (9% of their portfolio) than other funds. However, other characteristics of LS funds' portfolios regarding bond issue size, rating, age, or duration are similar to those of other funds. Also, on average, both LS and non-LS funds invest about 55% of their portfolios in corporate bonds, 15% in government bonds, and 21% in other securities.

Bond mutual funds have relatively high turnover. In our sample, the turnover in corporate bonds within a fund's portfolio is 16.28% per month, equivalent to almost 200% over a year for funds that report their positions monthly. The summary statistics of the fund-position level variables in Table 1, Panel B show that each bond's trade accounts for just about 0.23 basis points of a fund's TNA, on average. However, LS funds' trades are more concentrated, with an average transaction equal to 0.30 basis points relative to the fund's TNA.

Most of our analysis focuses on LS funds. We consider non-LS funds in placebo tests to validate our conjectures on the effects of the leverage ratio constraints. We control for a host of fund characteristics to assuage concerns that omitted factors may drive our findings.

3.4 Bonds and Dealers

As is common in the literature (see, e.g., Bessembinder et al. (2018)), we consider only bonds in the FISD database that are classified as non-puttable U.S. corporate debentures and U.S. corporate bank notes (bond types CDEB or USBN) with a reported maturity date. We clean bond transactions in the regulatory version of TRACE for same-day corrections, cancellations, and reversals as described by Dick-Nielsen and Rossi (2019), and further exclude i) bonds with less than five trades over the sample period; ii) bonds with a reported trade size that exceeds the bond's issue size; iii) transactions reported after the bond's amount outstanding is recorded by FISD as zero; and iv) primary market transactions. Our sample includes a total of 20,436 distinct bond issues (CUSIPs).

We aim to test whether LS funds strategically supply liquidity in bonds that are relatively more affected by the leverage ratio regulation. Such a test requires that we quantify the exposure of each bond to the regulation. Therefore, similar to Adrian et al. (2017), we

sample in 2010 (not in 2003). Furthermore, we define funds with a positive past *LS score* (rather than the top-20%) as LS funds.

construct a measure of past intermediation activity in a bond by bank-affiliated dealers that are subject to the leverage ratio constraints. We use the regulatory version of TRACE, which includes unmasked dealer identities. In line with the literature, we define European and Japanese bank-affiliated dealers and U.S. bank-affiliated dealers subject to the supplementary leverage ratio requirements as constrained (Correa et al. 2022). We then define the degree to which bond j is constrained in month m as the share of positive inventory holdings that constrained dealers built up in bond j during the first twenty days of the month relative to bond j's issue size:

$$\text{Constr. Dealers' Inventory Holdings}_{j,m} = \frac{\sum_{d=1}^{N} \max\left\{ \sum_{t_m=1}^{20} Inventory_{d,j,t_m}, 0 \right\} \cdot \mathbb{1}_{d \in C}}{Offering\ Amount_j}, \quad (2)$$

where d indexes dealers active in bond j during month m. C denotes the subset of dealers that are defined as constrained, t_m indexes the calendar day in a given month, and $Inventory_{d,j,t_m}$ is the incremental inventory that dealer d takes on in bond j during day t_m.[4] Positive $Inventory_{d,j,t_m}$ reflects a dealer' net purchases of bond j on a given day, while negative $Inventory_{d,j,t_m}$ reflects the dealer's net sales of the bond. We only aggregate dealers' cumulative inventory changes that are positive, as bank-affiliated dealers' purchases and not their sales generate balance sheet pressure under the leverage ratio rules.[5] A limitation of this approach is that we disregard dealers' short positions, which are, however, negligible in the corporate bond market, especially after the global financial crisis (Hendershott et al. 2020).

Using data over the entire sample period and ignoring bonds that have not been traded in the first 20 days of a month and have zero cumulative inventory changes, we sort bonds into quintiles based on their cumulative inventory changes of constrained dealers relative to the bonds issue size (Constr. Dealers' Inventory Holdings$_{j,m}$ in Equation 2). Then, we define bonds in the top quintile as constrained bonds; the indicator variable constrained bond is set to zero for all the other bond observations in the sample (including the bonds with zero inventory changes).[6]

[4] Due the to lack of information on the stock of bond holdings in a dealer's inventory, we focus on daily inventory changes and cumulate them over a number of trading days to infer the inventory level (Bessembinder et al. 2018).

[5] We verify that our trading results are similar if we also include the negative inventory changes.

[6] While the dichotomic variable is easy to interpret, we will show that our results are invariant to alter-

While constrained dealers can sell any securities on their balance sheets to meet the leverage ratio requirements, our proxy captures that unregulated dealers who are willing to accumulate inventories may be unavailable for these constrained bonds when the rest of the market is selling because market-making in a particular bond tends to be provided by the same dealers over time (Breckenfelder and Ivashina 2021). As a result, when regulated dealers have recently accumulated large inventories in a bond, mutual funds' liquidity provision becomes particularly critical for that bond.[7]

Table 1, Panel C summarizes the characteristics of the bonds in our sample. The first five columns highlight the whole sample (908,354 bond-month observations). On average, the bond maturity is ten years, the issue size is \$687 million, and the bond's age is 5.4 years. Approximately 71% of the bond-month observations are for investment-grade bonds, and the average credit rating is about BBB-. Together, all taxable mutual funds own about 10% of our sample's average bond issue.

The last two columns of Table 1, Panel C distinguish between constrained and unconstrained bonds. Throughout our sample period, constrained dealers' shares of inventory holdings relative to the bond issue size are around 2.30% for constrained bonds but just 0.21% for unconstrained bonds. While dealers' inventory holdings may depend on exogenous shocks to the demand for different bonds, they are also an endogenous choice of the dealers, who could otherwise arrange customer trades. For this reason, it is important to compare the characteristics of constrained and unconstrained bonds, which tend to be similar, with a few exceptions. Constrained bonds are larger in issue size, younger, and have slightly worse credit ratings. In addition, constrained bonds are slightly more liquid than unconstrained bonds, as measured by several liquidity measures. Overall, this evidence suggests that dealers are willing to hold larger inventories of bonds that are easier to sell. This should make it harder to find any positive effects of liquidity provision on funds' performance. Nevertheless, to alleviate concerns that dealers choose in which bonds they hold high inventories at quarter ends in a way that may affect the interpretation of our findings, we show that our main results are robust when we match constrained bonds to similar but unconstrained counterparts.

native definitions of bond constraints, which exploit the continuous Constr. Dealers' Inventory Holdings$_{j,m}$ and take into account dealers' distance from the regulatory minimum capital.

[7]Put differently, we do not expect the constraints on the bank-affiliated dealers handling a security to matter if market participants are not selling.

Specifically, we estimate the propensity of a bond to be defined as constrained as a function of its age, maturity, illiquidity, issue size, and rating. Table A1 in the Internet Appendix shows how these bond characteristics are related to the probability that a bond is constrained. Then, for each constrained bond in each month, we select (with replacement) an unconstrained bond with the smallest absolute distance in terms of the estimated propensity score. We exclude from the pool of unconstrained bonds any securities in the fourth quintile of $Constr.\, Dealers'\, Inventory\, Holdings$ because they may be almost as constrained as our constrained bonds. Table A2 provides the covariate balance, showing that the characteristics of constrained and unconstrained bonds are not statistically different in this matched sample.

4 Leverage Constraints and Funds' Trading

We begin by examining the impact of the leverage ratio regulations on mutual funds' trading behavior, focusing on distinct subsets of mutual funds and corporate bonds. Specifically, we concentrate on mutual funds specializing in liquidity provision, as they are most apt to take advantage of the constraints on bank-affiliated dealers arising from the leverage ratio regulation. In addition, we focus on investment-grade bonds because inventories of high-yield bonds were already subject to Basel II risk-weighted capital regulations, which are more stringent. Consequently, we study how LS funds' trading in investment-grade bonds changed following the introduction of the leverage ratio requirements.

Since the effects of the leverage ratio requirements should be particularly strong for regulated dealers at quarter ends —that is, close to reporting dates when the constraints are verified—we test whether the trading of LS funds changes in the last month of each quarter following the introduction of the leverage ratio requirements. We estimate the following fund-bond-month level regression:

$$\begin{aligned} Fund\, Position\, Change_{i,j,t} = \beta_0 + \beta_1\, \mathbb{1}[QE] + \beta_2\, \mathbb{1}[QE] \times \mathbb{1}[LR\ Period] \\ + \theta_1'\, \mathbf{M_{j,t}} + \theta_2'\, \mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}, \end{aligned}$$

where the dependent variable is

$$Fund\, Position\, Change_{i,j,t} = \frac{Par\, Change_{i,j,t} \times p_{j,t-1}}{TNA_{i,t-1}} \times 10,000,$$

and $Par\,Change_{i,j,t}$ refers to the change in par amount of bond j by fund i in period t, and $p_{j,t-1}$ is the price of bond j at the end of period $t-1$. $TNA_{i,t-1}$ refers to fund i's total net assets at the end of period $t-1$. $\mathbb{1}[LR\ Period]$ is an indicator variable that equals one during the leverage ratio period, that is, from 2015 onwards, and $\mathbb{1}[QE]$ is an indicator variable capturing the last month of each quarter. We control for bond and fund characteristics, $\mathbf{M_{j,t}}$ and $\mathbf{M_{i,t}}$, respectively, and also include the interactions of bond and year fixed effects, $\eta_j \times \lambda_y$, to account for the fact that bond and fund level shocks could drive different trading behavior. We test whether fund i disproportionately increases its position in bond j during month t if month t is the last month of the quarter and whether this behavior emerges during the leverage ratio period.

Table 2 shows that LS funds purchase more investment-grade bonds at quarter ends following the implementation of the leverage ratio requirements (column 1), whereas this pattern is not observed before the introduction of the regulation (column 2). In column 3, we show that the difference between the coefficients in the first two columns is not only statistically significant but also economically meaningful, as the 0.19 increase in quarter-end purchases amounts to almost 100% of the average position change in an investment-grade bond made by an LS fund (that is, 0.19 divided by 0.20). Figure 1 illustrates the year-by-year dynamics of the effect documented in Table 2. The figure reveals that LS funds' propensity to purchase investment-grade bonds at quarter ends becomes apparent only after the introduction of the leverage ratio constraint. It also supports our assumption that the regulation became binding in 2015, with the public disclosure of the leverage ratio.

Table 3 examines whether alternative factors could have similarly affected mutual funds' trading patterns. If all funds, regardless of their liquidity strategies, had begun to increase their purchases of investment-grade bonds at quarter ends following the implementation of leverage ratio constraint, this could suggest that the finding in Table 2 is not directly linked to the introduction of the leverage ratio because non-LS funds are unlikely to engage in liquidity provision. Thus, in columns 1 to 3, we consider non-LS funds as a placebo group and test whether they also began to purchase more investment-grade bonds at quarter ends once the leverage ratio regulations were introduced.[8] For non-LS funds, we observe neither quarter-end effects nor changes in trading behavior following the introduction of the leverage ratio

[8] Figure A1 in the Internet Appendix shows the year-by-year dynamics of this effect.

regulations. This finding indicates that the strategies of liquidity-demanding funds have not been affected by the leverage ratio requirements and supports our claim that the increase in quarter-end purchases of investment-grade bonds by LS funds is associated with their liquidity provision in months when bank-affiliated dealers encounter higher regulatory costs in expanding their balance sheets.

Columns 4 to 6 of Table 3 examine LS funds' trading in high-yield bonds as a second placebo test. Bank-affiliated dealers' high-yield bond inventories have been subject to Basel II risk-weighted capital ratio regulations throughout the entire sample period. Thus, we anticipate no shifts in LS funds' propensity to provide liquidity in high-yield bonds. We find that LS funds consistently increase their purchases of high-yield bonds in quarter-end months throughout the entire sample period and do not observe any statistically significant changes in their behavior following the introduction of the leverage ratio regulations. This evidence is consistent with Basel II risk-weighted capital ratios becoming more binding at quarter ends, thus providing trading opportunities for LS funds throughout the whole sample period.

To sharpen our analysis, we consider that mutual funds' liquidity provision at quarter ends should be particularly necessary for investment-grade bonds handled by dealers affected by the regulation when the market is selling. We do so using our proxy for constrained bonds. Since regulated dealers have accumulated inventories during the first 20 days of the month, market participants must have been selling these bonds. At the same time, the large inventories accumulated by regulated dealers suggest that they are the natural market makers of these securities and that unregulated dealers are unlikely to handle these bonds and provide liquidity. Therefore, at quarter ends when the leverage ratio is binding, constrained bonds are the most likely to lack natural liquidity providers.

We test whether LS funds purchase relatively more of the constrained investment-grade bonds, as captured by the dummy $\mathbb{1}[\textit{Constr. Bond}]$. To do so, we augment our fund-bond-month level regression with a triple-interaction term, as follows:

$$
\begin{aligned}
Fund\,Position\,Change_{i,j,t} = {} & \beta_0 + \beta_1\,\mathbb{1}[Constr.\,Bond_{j,t}] + \beta_2\,\mathbb{1}[LS\,Fund_{i,t}] + \beta_3\,\mathbb{1}[QE] \\
& + \beta_4\,\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond_{j,t}] + \beta_5\,\mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr.\,Bond_{j,t}] \\
& + \beta_6\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] + \beta_7\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr.\,Bond_{j,t}] \\
& + \theta_{\mathbf{1}}'\,\mathbf{M_{j,t}} + \theta_{\mathbf{2}}'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t},
\end{aligned}
$$

where $\mathbb{1}[LS\ Fund]$ is an indicator that is one if the fund has a liquidity-supplying trading style. We focus on the post-leverage-ratio period and test whether LS funds indeed provide more liquidity in quarter-end months. We also use non-LS funds, which appear not to have changed their behavior after the introduction of the regulations in Table 3, as a control group to address the concern that *constrained* investment-grade bonds may differ along unobserved dimensions.

Table 4 reports the estimates. During quarter-end months, LS funds indeed appear to purchase larger volumes of *constrained* investment-grade bonds —that is, the bonds handled by bank-affiliated dealers that the market is likely to be willing to sell— relative to other funds. The estimates in column 2 show that liquidity-demanding funds do not purchase *constrained* investment-grade bonds at quarter ends. The difference between LS and non-LS funds is both statistically and economically significant in column 3, as LS funds' increased purchases of constrained bonds at quarter ends are equivalent to around 52% of the average change in a fund's position size (that is, 0.089 divided by 0.17).

In column 4, we also consider that the leverage ratio constraint is more binding for bank-affiliated dealers with scarce capital. These dealers should be even more reluctant to accumulate inventories than other regulated dealers at quarter ends. The bonds handled by these more constrained dealers should, in turn, need more liquidity provision when the rest of the market is selling. To take this into account, we retrieve banks' reported leverage ratio data from S&P Global SNL Financial,[9] and construct new proxies for constrained bonds, distinguishing whether bank-affiliated dealers closer to or further from the leverage ratio constraint have accumulated inventories in a given bond. Specifically, $\mathbf{1}[Constr.\,Bond\,|\,\Delta\,LR\,Min. \leq$

[9] S&P Global SNL Financial includes information on U.S. banks' supplementary leverage ratio from the FRY-9C filings. We hand-collect information from publicly available balance sheets for bank-affiliated intermediaries not covered in S&P Global SNL Financial.

50%] is a dummy that equals one if the cumulative inventories of bank-affiliated dealers with below-median distance from the regulatory minimum capital in a bond, relative to the bond's issue size, are in the top quintile; $\mathbf{1}[Constr.\, Bond\,|\,\Delta\, LR\, Min. > 50\%]$ is defined analogously considering the inventories of bank-affiliated dealers whose distance from the regulatory minimum capital is above the median. Consistent with our hypothesis that LS funds purchase bonds that require liquidity provision at quarter ends, we find that the effect is entirely driven by the purchases of bonds in which dealers closer to the regulatory minimum capital have accumulated larger inventories. Importantly, the coefficient of interest in column 4 is almost double the one in column 3, where we do not consider regulated dealers' distance from the regulatory minimum capital.

The above findings are robust to several robustness checks. First, in Table A3 of the Internet Appendix, we substitute the constrained bond dummies that facilitate the interpretation of the results for their continuous counterpart and show that our findings are unchanged. Second, we evaluate the extent to which differences in the implementation of the leverage ratio regulations across jurisdictions matter for our findings. In Table A4 of the Internet Appendix, we consider separately dealers affiliated with banks that report the leverage ratios at quarter ends and those affiliated with banks that report the leverage ratios as quarterly averages, when we define the constrained investment-grade bond dummy. Our results are invariant and similar for the two definitions of constrained bonds, supporting our empirical choice not to distinguish between the two categories of bank-affiliated dealers.

Third, to further address the lingering concern that bonds in which bank-affiliated dealers accumulated inventories before quarter ends differ from other bonds in dimensions that may drive our findings, we implement a matching methodology that pairs constrained bonds with comparable unconstrained bonds based on a set of observables. Then, we re-estimate the regressions in Table 4 using our matched bond sample. The results in Table A5 of the Internet Appendix are qualitatively and quantitatively unchanged.

So far, we have attributed LS funds' propensity to purchase more investment-grade bonds at quarter ends to the leverage ratio constraints, which negatively affect bank-affiliated dealers' willingness to intermediate investment-grade bonds. However, the G-SIB surcharges were also introduced during our sample period. Because the G-SIB surcharges are calculated based on year-end balance sheet values (Behn et al. 2022), it is unclear whether we are capturing an increase in LS funds' propensity to provide liquidity at the end of the year due to the G-SIB surcharges or the effect of the leverage ratio requirements. In the former case, even though the economic mechanism would be similar, as a temporary retraction of bank-affiliated dealers from liquidity provision due to higher regulatory costs would drive LS funds' behavior, we should not attribute the observed effect to the leverage ratio regulations. To address this concern, we re-estimate the regressions in Tables 2 and 4 separately for quarters one to three and quarter four. Tables A6 and A7 in the Internet Appendix show that our results are qualitatively invariant when we consider LS funds' trading in investment-grade bonds during the first three quarters of a year. Interestingly, the estimated effects are particularly large when we consider the last quarter of a year, suggesting that bank-affiliated dealers' propensity to retract from liquidity provision is stronger at year ends when the additional costs of G-SIB supplemental capital requirements magnify the effects of the leverage ratio regulations.[10]

5 Leverage Constraints and Funds' Performance

5.1 Performance of Quarter-end Trades

Because the changes in LS funds' trading patterns appear economically relevant, we explore whether their quarter-end trades in constrained bonds are particularly profitable. We follow Kacperczyk et al. (2014) and consider as a proxy for a trade return the change in a fund's position in a bond from periods $t-1$ to t multiplied by the bond's abnormal return in the next period (from t to $t+1$). To estimate a bond's abnormal return, we first take into account that bond duration has large effects on bond valuations when interest rates change and use the duration-adjusted bond return, calculated as the difference between a bond's return and its duration-matched risk-free return, following van Binsbergen et al. (2024).[11] We then calculate the abnormal return by subtracting the bond's expected return from the duration-adjusted return. Following Dickerson et al. (2023), we calculate the expected return using a market model with the parameters estimated over a 36-month rolling window. We

[10]This result, together with the evidence that LS funds' propensity to provide liquidity is stronger in the last month of each quarter, indicates that seasonality in mutual funds' trading is unlikely to drive our findings (Kamstra et al. 2017).

[11]We obtain duration-matched risk-free returns from https://openbondassetpricing.com/data.

use the bonds credit-rating-matched index as the only market factor.

Naturally, our proxy for trading returns is higher if a fund purchases relatively more of a security that ends up having high returns over the following month. If liquidity provision benefits a fund's performance, we expect end-of-quarter purchases to have become particularly profitable during the leverage ratio period. This is precisely what we find in Table 5. In column 1, LS funds' purchases of investment-grade bonds during quarter-end months appear to outperform similar purchases during other months by 0.044 basis points. This is equivalent to about 40% of the standard deviation of the dependent variable. The economic magnitude is even larger in column 3, where we compare the profitability of the trade before and after the leverage ratio implementation. On average, LS funds' trades in investment-grade bonds appear to outperform similar trades by about 0.1 basis points more after the introduction of the leverage ratio. This represents an increase of 90% relative to the standard deviation of the dependent variable.

While columns 1 to 3 test for differences in performance of all quarter-end purchases relative to other purchases, column 4 considers the quarter-end purchases in constrained bonds. On average, after the introduction of the leverage ratio, the outperformance of LS funds' quarter-end purchases of constrained investment-grade bonds is 0.042 basis points larger than the outperformance of other quarter-end purchases during the same period. This finding further supports the conjecture that LS funds benefit from the constraints on bank-affiliated dealers.

Table A8 in the Internet Appendix presents the average next-month portfolio abnormal returns of all investment-grade bonds purchased by LS funds during quarter-end versus non-quarter-end months, distinguishing between pre- and post-leverage ratio periods and constrained and unconstrained bonds. The table presents average abnormal returns for different subsamples and shows that LS funds' purchases of constrained investment-grade bonds during the last month of a quarter outperform their other purchases after the introduction of the leverage ratio. This effect is economically meaningful, as the outperformance of constrained bond purchases over other purchases is 0.39% per month (or 4.68% on an annualized basis) higher at quarter ends than non-quarter ends. Moreover, we find no statistically significant outperformance for quarter-end purchases of constrained investment-grade bonds before the introduction of the leverage ratio constraints.

5.2 Funds' Alpha

Overall, LS funds appear to take advantage of bank-affiliated dealers' leverage ratio requirements and provide liquidity when the constraints become particularly tight. In this section, we explore how this behavior affects LS funds' overall performance.

We measure performance using a fund's monthly alpha, estimated with the factor model of Chen and Qin (2017). Specifically, we estimate the model parameters over a rolling window of 24 months before month t and calculate the benchmark return using the estimated parameters and the factor values in month t. We test whether the alpha of LS funds changes relative to other funds after the introduction of the leverage ratio constraints, controlling for funds' strategic focus with interactions of fund category and time fixed effects and fund time-varying characteristics (including lagged flows, lagged alpha, broker affiliation dummy, age, size, family size, average maximum rear load, % cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, average bond issue size, and average bond age).

Since in Table 3 non-LS funds appear not to have changed their trading behavior after the introduction of the leverage ratio regulations, we use non-LS funds as a control sample and estimate the following difference-in-differences regression at the fund-month level:

$$\begin{aligned} Fund\,Alpha_{i,t} = {} & \beta_0 + \beta_1\, \mathbb{1}[LS\ \ Fund_{i,t}] + \beta_2\, \mathbb{1}[LR\,Period] \times \mathbb{1}[LS\ \ Fund_{i,t}] \\ & + \theta'\, \mathbf{M_{i,t}} + \eta_c \times \lambda_t + \varepsilon_{i,t}. \end{aligned}$$

The dependent variable, $Fund\,Alpha_{i,t}$, refers to the monthly fund alpha. The remaining variables are defined as in the earlier tests. Specifically, $\mathbb{1}[LR\,Period]$ is an indicator variable that equals one during the leverage ratio period. $\mathbb{1}[LS\ \ Fund]$ equals one for LS funds. $\mathbf{M_{i,t}}$ refers to a vector of time-varying fund controls, η_c denotes fund-category fixed effects, and λ_t denotes month fixed effects (which absorb the direct effect of $\mathbb{1}[LR\,Period]$). Our coefficient of interest is β_2, which measures the change in performance from before to after the introduction of the leverage ratio constraints for LS funds relative to non-LS funds.

Table 6 reports the results. In columns 1 and 2, we consider funds focusing on investment-grade bonds. Consistent with our earlier findings, we find that LS funds outperform non-LS funds during the leverage ratio period. Following the introduction of the leverage ratio constraints, the outperformance of investment-grade LS funds, relative to non-LS funds, appears statistically and economically significant at approximately 2.2 basis points per month or 0.26% per annum (column 1). The estimates are qualitatively and quantitatively similar when we exclude the Taper tantrum months (02/2013-05/2013) from the control sample. The taper tantrum is a period of turmoil before the introduction of the leverage ratio constraint, during which liquidity provision by LS funds may have been particularly profitable. Therefore, it is unsurprising that we estimate a slightly larger alpha for LS funds after the introduction of the leverage ratio regulation in column 2.

Figure 2 provides dynamic estimates of the performance of LS funds focusing on investment-grade bonds. Not only does it confirm that their alpha becomes statistically different from zero after the introduction of the leverage ratio constraint, but also that the effect emerges in all years after 2015.

Columns 3 and 4 of Table 6 consider a placebo based on funds focusing on high-yield bonds. Consistent with our prior, we find no evidence that high-yield LS funds' performance, relative to other high-yield funds, changes in the leverage ratio period. These findings suggest that constraints on the leverage ratio of bank-affiliated dealers make liquidity provision in investment-grade bonds by mutual funds more profitable and consequently enhance their performance. The introduction of the leverage ratio disproportionately increased the cost of holding inventories in the safest investment-grade bonds because the capital that bank-affiliated dealers have to set aside depends on the size of the bank's balance sheet but not on the risk of the bank's assets. It is, therefore, unsurprising that only the performance of investment-grade focused funds benefits from the leverage ratio rules. Interestingly, high-yield focused LS funds exhibit an alpha over the entire sample period but only when we exclude the taper tantrum months, suggesting that liquidity provision in high-yield bonds is associated with more volatile returns.

To provide additional evidence that the newly introduced regulations affect mutual funds' performance, we consider the months of a quarter during which LS funds obtain higher alpha. The leverage constraints are expected to create more significant distortions at the end of each quarter when European and Japanese bank-affiliated dealers and U.S. dealers subject to the supplementary leverage ratio requirements must satisfy the leverage ratio constraints. If the outperformance of LS funds indeed derives from the fact that the leverage constraints increase the profitability of supplying liquidity when bank-affiliated dealers are constrained, we should observe that the positive alpha is realized during the first month of each quarter, i.e., the month following each quarter-end month. This is precisely what we observe in Table 7. Consistent with our results on trade returns in Table 5, we observe that following the introduction of the leverage ratio constraint, LS investment-grade funds significantly outperform other investment-grade focused funds during the first month of each quarter, when presumably the prices of the bonds most negatively affected by dealers' constraints converge back to their fundamental value. We do not observe such outperformance in the second or third month of each quarter.

6 Which Funds Take Advantage of Liquidity Provision?

Our results demonstrate that the Basel III leverage ratio requirements have created profitable trading opportunities for bond mutual funds in investment-grade bonds. Banks could favor their affiliated funds to retain potential profits from liquidity provision by selling them undervalued bonds. However, since engaging in liquidity provision for investment-grade bonds is profitable and involves limited risk, all LS mutual fund managers should have incentives to compete for these trades, irrespective of their affiliation with a dealer. Also, LS mutual funds do not necessarily trade with bank-affiliated dealers but are likely to purchase from other market participants who are unable to sell to the regulated dealers that typically handle the bonds. It is thus an empirical question whether all funds, or exclusively bank-affiliated mutual funds, engage in liquidity provision to benefit from the opportunities created by the regulation.

We identify funds affiliated with a given dealer by matching fund management companies and fund advisors from CRSP to our set of constrained banks by name. We then define a fund as affiliated with a given (constrained) dealer if either the fund management company or the fund advisor is affiliated with the constrained bank dealer. Column 1 of Table 8 considers to what extent affiliated mutual funds are more likely to engage in liquidity provision in investment-grade bonds. We focus on the leverage ratio period and LS funds trading in investment-grade bonds. The estimates confirm our earlier results that LS funds provide liquidity in constrained investment-grade bonds at quarter-ends. The statistically insignificant coefficient estimate on the triple interaction $\mathbb{1}[QE] \times \mathbb{1}[Constr.\, Bond] \times \mathbb{1}[Bank - aff.]$ indicates that bank-affiliated mutual funds are not more inclined to engage in liquidity provision than other LS funds, as is consistent with the conjecture that all mutual funds with liquidity-supplying strategies should have incentives to undertake profitable trades that involve limited risk.

It comes as no surprise that this finding contrasts with evidence that when liquidity dried up at the onset of the COVID-19 pandemic, insurance companies with stable funding and not open-ended bond mutual funds provided liquidity, particularly to those dealers with whom they had stronger prior trading relationships (O'Hara et al. 2022). March 2020 represents a period of significant turmoil for the corporate bond market, during which even investment-grade bonds involved significant risks of future downgrades and further price drops. The expected risk-adjusted payoff of engaging in liquidity provision was, therefore, likely to be low. Even among institutions with stable funding conditions, such as insurance companies, only those with close relationships to dealers, which could expect to be compensated through better execution quality and primary market allocations in the future, had incentives to supply liquidity. By contrast, mutual funds' liquidity provision in regular times, when fund managers have no reason to expect large redemptions, involves limited risks. Thus, most funds with LS strategies are willing to engage in these types of trading opportunities.

While both bank-affiliated and unaffiliated LS funds equally provide liquidity, it appears plausible that constrained bank dealers favor affiliated funds by directing more profitable trades to them. While our data do not allow us to observe actual trading relationships, we test this hypothesis by exploring whether bank-affiliated funds perform better when engaging in liquidity provision. We consider all investment-grade focused funds and test whether bank-affiliated LS funds outperform other LS funds. This is precisely what we observe in column 2 of Table 8. While all investment-grade funds generate an alpha from LS strategies after the introduction of the leverage ratio regulations, the alpha of bank-affiliated investment-grade LS funds is over three times larger than that of other investment-grade LS funds. This finding suggests that constrained bank dealers direct their best trades to their affiliated funds. Thus, mutual funds appear not only to have substituted bank-affiliated dealers in their liquidity provision but also to complement banks that appear to transfer profits to less regulated entities, possibly within the same financial conglomerate.

7 When Do Funds Engage in Liquidity Supply?

In what follows, we explore whether the profitability of liquidity provision after the introduction of the leverage ratio constraints has led more investment-grade funds to adopt liquidity-supplying strategies. While trading style is a strategic choice that varies little over time and depends on funding conditions and managerial incentives (Cella et al. 2013; Anand et al. 2021), funds should be more likely to adopt LS strategies if they expect them to be profitable. Not only could the recent performance of LS funds be correlated with the expected profitability of LS strategies, but positive performance leads to higher flows, increasing funds' ability to engage in liquidity provision.

To test these conjectures, we consider a linear probability model with a dummy capturing whether a fund has a positive LS score during a month as the dependent variable. This allows us to detect short-term changes in a fund's strategy, which we relate to a rolling average of the performance of all LS funds over the previous 12 months. We also consider whether an individual fund's flows (rolling averages over the past 12 months) affect its propensity to provide liquidity, controlling for the fund's strategic focus and other characteristics, by including Morningstar fund category dummies and time-varying fund and portfolio characteristics.

Table 9 shows that investment-grade focused funds with higher recent flows are more likely to have a positive LS score. The probability that a fund has a positive LS score is also positively related to the previous performance of LS strategies. Both the net individual flows and recent LS performance only affect investment-grade funds' LS strategies during the leverage ratio period. This suggests that the industry has adjusted to the trading opportunities created by the new regulations but also that liquidity provision may have become more dependent on mutual funds' funding conditions in a period in which more liquidity is provided by mutual funds. In terms of economic magnitude, a standard deviation increase in the past 12-month average alpha of LS strategies (0.08) raises the probability of a fund pursuing an LS strategy by about 0.04 (that is, 0.511 from column 1 times 0.08), which is highly significant from an economic point of view, given that the average fraction of LS funds is between 0.24 and 0.27 during our sample period. Notably, the statistically insignificant coefficient on the indicator for bank-affiliated funds confirms our previous conclusion that all funds have incentives to engage in liquidity provision, irrespective of their relationships with dealers.

While the finding that mutual funds' liquidity provision in investment-grade bonds responds to trading opportunities suggests that the regulations should have limited negative effects on market functioning, their liquidity provision appears to be conditional on prior performance. In addition, funds that experience outflows are less likely to continue pursuing LS strategies, indicating that funds face constraints related to their open-ended capital structure.[12] These findings raise concerns that liquidity provision in the bond market may have become more dependent on fund flows and performance, and the liquidity of investment-grade bonds may suddenly drop. Outflows during episodes of turmoil, as experienced in March 2020 at the onset of the COVID-19 pandemic (Falato et al. 2021), can consequently explain, at least in part, why liquidity conditions quickly deteriorated, especially for investment-grade bonds (Haddad et al. 2021; Kargar et al. 2021). In the following section, we test whether a partial shift in liquidity provision from bank-affiliated dealers to open-ended bond mutual funds has systematically affected bond liquidity and returns.

8 Effects of Leverage Constraints on Corporate Bonds

8.1 Extent of Mutual Funds' Liquidity Provision in Corporate Bonds

To evaluate whether mutual funds' liquidity provision in investment-grade bonds can be large enough to affect bond liquidity and returns, we divide the sum of LS funds' monthly net purchases of an investment-grade corporate bond experiencing a positive inventory cycle by the entire dealer sector's average inventories in the same bond. Table 10 presents the average across all bonds that LS funds are trading in a given month (Panel A) and across all bonds traded by mutual funds in a given month (Panel B).

It shows how mutual funds' liquidity provision has changed. After the introduction of the leverage ratio regulations, LS funds' liquidity provision is concentrated in the last month

[12] In an earlier sample period, Anand et al. (2021) find that in periods of turmoil, LS funds provide liquidity by selling bonds that the market demands but not by purchasing.

of the quarter and involves only constrained bonds. By contrast, before the introduction of the leverage ratio, liquidity provision was more prevalent in the first two months of the quarter and only slightly more prevalent in bonds in which regulated financial institutions had accumulated larger inventories.

Since LS funds help absorb, on average, 15% of dealers' mean inventories in constrained bonds at quarter ends, funding shocks affecting bond mutual funds can significantly affect the corporate bond market. In what follows, we evaluate to what extent this is the case.

8.2 Liquidity

Mutual funds are open-ended organizations, subject to redemptions. Since mutual funds' liabilities are unstable, their ability to provide liquidity depends on their investors' willingness to hold their shares. This implies that liquidity conditions and returns of corporate bonds that regulated dealers intermediate may have become more dependent on mutual funds' flows.

To test for the effect of bond mutual funds' funding conditions on bond liquidity, we estimate the following regression at the bond-month level:

$$\begin{aligned}
Illiquidity_{j,t} = {} & \beta_0 + \beta_1\, \mathbb{1}[Constr.\, Bond_{j,t}] + \beta_2\, \mathbb{1}[Flow_t \in\, [0\%, 20\%]] \\
& + \beta_3\, \mathbb{1}[Constr.\, Bond_{j,t}] \times \mathbb{1}[Flow_t \in\, [0\%, 20\%]] \\
& + \beta_4\, \mathbb{1}[Constr.\, Bond_{j,t}] \times \mathbb{1}[LR\, Period] + \beta_5\, \mathbb{1}[Flow_t \in\, [0\%, 20\%]] \times \mathbb{1}[LR\, Period] \\
& + \beta_6\, \mathbb{1}[Constr.\, Bond_{j,t}] \times \mathbb{1}[Flow_t \in\, [0\%, 20\%]] \times \mathbb{1}[LR\, Period] \\
& + \beta_7\, Agg.\, Flows_t + \beta_8\, Matched\, Ret_t + \gamma'\, \mathbf{M_{j,t}} + \eta_s + \lambda_q + \varepsilon_{j,t}
\end{aligned}$$

The dependent variable, $Illiquidity_{j,t}$, is a bond's monthly illiquidity. Following Adrian et al. (2017), we construct three standard metrics of corporate bond illiquidity: effective bid-ask spread, imputed round-trip cost, and the interquartile price range. We then extract the first principal component of the three individual measures and use it as our main illiquidity proxy.[13] As in our earlier specifications, $\mathbb{1}[LR\, Period]$ is an indicator that takes the value of one after 2015; the indicator $\mathbb{1}[Constrained_{j,t}]$ captures bonds in which bank-affiliated dealers have accumulated substantial inventories; $\mathbb{1}[Flow \in [0\%, 20\%]]$ is an indicator that

[13]During our sample period, the first principal component of the three illiquidity proxies explains around 68% of the variation.

equals one if the aggregate fund flows to investment grade-focused funds during month t are in the bottom 20 percent of the sample and zero otherwise; $\mathbf{M_{j,t}}$ refers to our set of bond-month controls; η_s denotes issuer fixed effects, and λ_q denotes quarter fixed effects.

Our objective is to test whether bond mutual funds' funding constraints impact liquidity conditions for investment-grade bonds to a larger extent after the introduction of the leverage ratio requirements. Similar to our previous tests, we anticipate that the effect will be driven by investment-grade bonds in which bank-affiliated dealers have accumulated inventories during previous months, which we hence define as *constrained.* Throughout the analysis, in addition to usual bond characteristics, we control for the selling pressure that a bond would experience if the mutual fund owners liquidated their portfolio pro rata when they experience large redemptions (flows in the bottom decile) using the variable flow-induced fire sales or $FIFS$.[14] We also control for aggregate mutual fund flows to investment grade-focused funds. These controls capture forced sales by mutual funds, allowing us to isolate the effect of missing liquidity provision by LS funds in constrained investment-grade bonds when large redemptions from the mutual fund industry occur, and LS funds cannot purchase constrained bonds.

Columns 1-3 of Table 11 report the results. After the introduction of the leverage ratio, constrained bonds appear to be less illiquid, which is consistent with the evidence that bank-affiliated dealers are more inclined to accumulate inventories in liquid securities. More importantly, constrained bonds have become more illiquid when the net flows to the bond mutual fund industry are in the bottom quintile. Since we control for the extent of flow-induced fire sales experienced by a security, we interpret the indicator for constrained bonds to capture the missing liquidity provision by bond mutual funds. This result thus suggests that mutual funds' retraction from liquidity provision affects liquidity conditions.

The effects of the regulations on bond liquidity are also economically significant. Specifically, after the introduction of the leverage ratio, illiquidity increases by about 5.8, or around 8.5% of its standard deviation, more for constrained investment-grade bonds when mutual funds experience significant redemptions, as captured by the indicator for bond mutual funds' flows in the bottom quintile. Notably, the estimates are qualitatively and quantitatively unchanged in the matched sample (Table A9 in the Internet Appendix), indicating that the

[14] Since our proxy for FIFSs does not use the fund's TNA and the bond price to value a position, we do not incur the criticism raised by Wardlaw (2020) that proxies for FIFSs can be mechanically related to returns.

leverage ratio regulations are likely to have increased the exposure of constrained bonds to liquidity risk arising from mutual fund redemptions.

8.3 Returns

Since the liquidity of investment-grade corporate bonds has become more exposed to redemptions from the bond mutual fund industry, negative realizations of liquidity risk could affect bond returns (Bao et al. 2011). In this section, we adapt our methodology to test whether the leverage ratio constraints also change the determinants of bond returns.

We focus on monthly returns and, to take into account that bond duration has large effects on bond valuations when interest rates change, we follow van Binsbergen et al. (2024) and compute the duration-adjusted bond return as the difference between a bond's return, $r_{j,t}$, and its duration-matched risk-free return.

In our regression model, we relate bond returns to the relevant (credit-rating-matched) index, which is the only factor that has been shown to consistently matter for corporate bond returns (Dickerson et al. 2023). Moreover, we control for a bond's FIFS and aggregate flows to bond mutual funds besides usual bond characteristics. We then include our variables of interest, capturing intermediaries' constraints. Specifically, we test whether corporate bonds that during the previous month have been intermediated to a larger extent by bank-affiliated dealers are more exposed to liquidity risk deriving from large outflows from the bond mutual fund industry and underperform when mutual funds' liquidity provision is constrained because aggregate flows are in the bottom quintile. As before, we also include issuer and quarter fixed effects.

Columns 4-6 of Table 11 report the results. Following the introduction of the leverage ratio constraints, constrained investment-grade bonds experience significant losses when the mutual fund industry experiences large redemptions. These effects are obtained after controlling for a bond's exposure to flow-induced fire sales. The estimates thus suggest that the missing liquidity provision by LS mutual funds can have significant adverse effects on bond returns. The effects are not only statistically but also economically significant. Constrained investment-grade bonds' excess returns drop by an additional 30.8 basis points relative to unconstrained investment-grade bonds during periods of large mutual fund outflows. This effect is present only after the introduction of the leverage ratio regulations. Notably, the matched bond sample estimates are qualitatively and quantitatively similar (Table A9 in the Internet Appendix).

9 Leverage Constraints and the COVID-19 Shock

Our analysis over the years 2010-2019, a period without major financial turmoil, highlights that in response to the leverage ratio constraints faced by banks, the liquidity and returns of investment-grade corporate bonds have become particularly sensitive to mutual funds' funding conditions. This section explores to what extent the leverage ratio constraints can help explain why liquidity conditions and returns sharply deteriorated for corporate bonds at the onset of the COVID-19 pandemic when especially investment-grade bonds experienced pronounced price dislocations (Haddad et al. 2021; Kargar et al. 2021; O'Hara and Zhou 2021).

In the first three weeks of March 2020, before the Federal Reserve's intervention, bond mutual funds experienced unprecedented redemptions that depressed bonds' valuations (Falato et al. 2021). While the tendency of mutual funds to sell liquid assets to meet redemptions contributed to the price dislocations experienced by investment-grade bonds relative to high-yield bonds (Ma et al. 2022), we investigate whether investment-grade corporate bonds intermediated by dealers subject to the leverage ratio constraints experienced more significant price dislocations than other investment-grade bonds. Since we control for a bond exposure to fire sales, evidence that constrained investment-grade bonds performed more poorly would indicate that the leverage ratio constraints amplified the shock when mutual funds experiencing large outflows had to retract from liquidity provision.

To begin our analysis, we examine whether illiquidity increased more for bonds that we defined as constrained. We lag our bond constraint measure, *Constr. Dealers' Inventory Holdings*$_{j,m-1}$, to avoid overlap with inventory changes due to the bond selloff in early March. That is, we consider bonds as constrained in March if they are in the top quintile of constrained dealers' inventory changes during the first 20 days of February. Then, we relate our measure of bond constraints with the bonds' illiquidity and returns.

The gravity of the COVID-19 pandemic became apparent during the first three weeks of March 2020, disrupting financial markets globally and ultimately leading to the Federal

Reserve's intervention to calm the U.S. corporate bond market and stabilize mutual fund flows on March 23. We thus consider a sample that includes bond issues' monthly returns for January-February 2020 and the first 22 days of March 2020.[15] We test whether constrained bonds performed particularly poorly during March 2020.

Table 12 reports the results from the panel regressions of our bond illiquidity measure and bond returns. We control for bond characteristics and include issuer fixed effects. The positive sign on the interaction term between the indicator variables capturing March 2020 and constrained bonds suggests that illiquidity increased more for investment-grade bonds affected by the leverage ratio constraints. Since we control for a bond's exposure to flow-induced fire sales, the effect of the proxy for the inventories accumulated by bank-affiliated dealers can be interpreted as capturing the effect of the missing bond mutual funds' liquidity provision during periods of large outflows.

The effect is not only statistically but also economically significant. Specifically, in March 2020, investment-grade bonds, in which dealers subject to leverage ratio constraints had built up inventory positions in February 2020, experienced a 17% (that is, 14.41 divided by 86.55) additional increase in illiquidity compared to unconstrained investment-grade bonds. Similarly, the returns of constrained investment-grade bonds decreased by around 30% more during March 2020 compared to other investment-grade bonds. Overall, this evidence confirms that the leverage ratio constraints can amplify negative shocks in the corporate bond market.

10 Conclusion

We provide the first evidence that banking regulations that reduce bank-affiliated dealers' willingness to accumulate bond inventories have spillover effects on unregulated financial institutions. Specifically, we show that when the leverage ratio constraints on bank-affiliated dealers are most binding, mutual funds provide more liquidity in the corporate bond market. Importantly, the regulation has benefited mutual funds' performance.

However, bond mutual funds' liquidity supply depends on their performance and flows and drastically decreases when the funds experience significant redemptions. Consequently,

[15] The Fed further intervened, easing the leverage ratio requirements in April 2020, after the end of our sample period.

liquidity in the corporate bond market has become more dependent on mutual funds' funding conditions. Not only does corporate bond liquidity deteriorate significantly when there are large redemptions from the bond mutual fund industry, but bonds' valuations also significantly decline.

Our findings show that unregulated institutions, substituting bank-affiliated dealers, can dampen the regulatory costs in normal market conditions. However, smaller balance sheets for regulated institutions and lower prospective bailout costs for the taxpayers entail a trade-off and come at a cost because investment-grade corporate bonds have become more exposed to negative shocks. While we refrain from drawing normative conclusions from our analysis, policymakers will have to consider these costs, together with those identified by previous literature for government securities and repo markets (Duffie 2018), in their evaluation of the leverage ratio requirements.

Appendix

Variable Definitions and Data Sources

This table defines the variables used in the analyses.

Variable	Definition
Fund-level variables	
Frequency: fund-month or coarser, depending on each fund's reporting frequency.	
Source: Morningstar, Morningstar Direct, CRSP, and Regulatory TRACE.	
Alpha	The fund's monthly return minus the benchmark return. The benchmark return is calculated using the factor model of Chen and Qin (2017). The factor loadings are estimated on a rolling basis, using the most recent 24 months.
Avg. maximum rear load	Value-weighted average across all share classes of the maximum charge for redeeming the mutual fund shares, as of the previous report date.
Bank affiliation	Dummy variable that equals one if either the fund management company or the fund advisor is affiliated with a bank dealer, and zero otherwise.
Broker affiliation	Dummy variable that equals one if the fund's family is affiliated with a (SEC-registered) broker-dealer institution, and zero otherwise.
Cash as % of portfolio	Holdings of cash and cash equivalents, as a percentage of TNA, as of the previous report date.
Corporate bonds as % of portfolio	Holdings of corporate bonds, as a percentage of TNA, as of the previous report date.
Flow	Sum of dollar flows across all share classes in the current month, as a fraction of TNA at the beginning of the month. Aggregate flow is the value-weighted average flow of all investment-grade focused mutual funds.

Variable Definitions and Data Sources [continued]

Variable	Definition
Government bonds as % of portfolio	Holdings of (U.S. and foreign) government bonds, as a percentage of TNA, as of the previous report date.
ln(1 + Fund age)	Natural log of 1 plus the fund's age in years, as of the previous report date.
ln(1 + Fund TNA)	Natural log of 1 plus the fund's total net assets (TNA) in dollars, as of the previous report date.
ln(1 + Family TNA)	Natural log of 1 plus the TNA in dollars of all taxable bond funds in the fund's family, as of the previous report date.
ln(1 + Portfolio avg. bond age)	Natural log of 1 plus the value-weighted average bond age in years, based on the offering date of each bond from Mergent FISD and the fund's portfolio positions as of the previous report date from Morningstar. The offering dates from Mergent FISD are only available for corporate bonds.
ln(1 + Portfolio avg. bond issue size)	Natural log of 1 plus the value-weighted average bond issue size in $1,000, based on the offering amount of each bond from Mergent FISD and the fund's portfolio positions as of the previous report date from Morningstar. The offering amounts from Mergent FISD are only available for corporate bonds.
Portfolio avg. coupon rate	Value-weighted average coupon rate, based on the coupon rate and the market value of each bond position as of the previous report date from Morningstar.
Portfolio avg. credit rating	Value-weighted average credit rating, based on the credit ratings from Moody's, S&P, and Fitch (obtained through Mergent FISD) and the fund's portfolio positions as of the previous report date from Morningstar. The ratings are only available for corporate bonds. If the ratings are available from all three agencies, the middle rating is used. If the ratings are available from two agencies, the worse rating is used. Rating scales are 1 for AAA (and equivalent), 2 for AA+, 3 for AA, and so on.
Portfolio average duration	Average modified duration in years, based on the authors' calculation given bond characteristics from Morningstar and Mergent FISD, within a fund's portfolio, weighted using the market value of each bond position as of the previous report date from Morningstar. Equity duration is assumed to be zero.
Return	Value-weighted average of return across all share classes in the current month.

Variable Definitions and Data Sources [continued]

Variable	Description
LS score	Liquidity supply score of the fund in the current month, calculated as in Anand et al. (2021).
LS fund	Dummy variable that equals one if the moving average of the fund-specific monthly LS_score over the past 24 month is positive, and zero otherwise.
LS fund performance$_{t-1,t-12}$	12-month rolling average of the equally-weighted average monthly alpha of all LS funds.
Position-level variables	
Frequency: *fund-bond-month or coarser, depending on each fund's reporting frequency.*	
Source: *Morningstar, unless specified.*	
Position change (in basis point of fund TNA)	Change in the fund's position in a bond as a fraction of the fund's total net assets (TNA) on the previous report date $(t-1)$. All position changes are calculated using prices at $t-1$. Values are expressed in basis points.
Bond-level variables	
Frequency: *bond-month*	
Source: *Mergent FISD, Morningstar and Regulatory TRACE.*	
Flow-induced fire sales (FIFS)	$FIFS_{j,t}$ is the sum of notional sales driven by redemptions in bond j in month t across all funds, normalized by the bond's issue size. Only redemptions from funds experiencing flows in the bottom decile (largest outflows, pooled sort) of the sample are considered to trigger fire sales. $$FIFS_{j,t} = \frac{\sum_i Flow_{i,t} \times \mathbb{1}_{\text{flow in bottom decile}} \times H_{i,j,t-1}}{Issue\,Size_j}$$ where $Flow_{i,t}$ is the percentage flows of fund i in month t, $\mathbb{1}_{\text{flow in bottom decile}}$ is a dummy variable that equals 1 if $Flow_{i,t}$ is in the bottom decile of the sample, and zero otherwise, $H_{i,j,t-1}$ is the par amount (in dollars) of bond j held by fund i at the end of month $t-1$, and $Issue\,Size_j$ is the issue size (in dollars) of bond j.

Variable Definitions and Data Sources [continued]

Variable	Description
Bond illiquidity	First principal component of three standard metrics of corporate bond liquidity: effective bid-ask spread, imputed round-trip cost, and the interquartile range measure (Adrian et al. 2017).
-*Effective bid-ask spread*	Following Boyarchenko et al. (2021), we define the daily effective bid-ask spread as the difference between the trade-size-weighted average prices of trades in which customers buy from dealers and those in which customers sell to dealers. We set negative observations to zero to maintain the intuition of the measure as a transaction cost. We aggregate the effective bid-ask spread to the bond-month level by computing the volume-weighted average of the daily measure.
-*Imputed round-trip cost*	Following Dick-Nielsen et al. (2012), we impute a round-trip of trades by identifying all trades in a respective bond that have the same trade size and occur on the same date. We then compute the percentage difference between the highest price and the lowest price within an imputed round-trip. We aggregate the imputed round-trip cost to the bond-day level by computing the volume-weighted average across all round-trips within the day, and to the bond-month level by computing the volume-weighted average of the daily measure.
-*Interquartile range*	Following Schestag et al. (2016), we define the interquartile range by dividing the difference between the 75th and the 25th percentiles of intraday trade prices in a given bond by the equally-weighted average trade price of the bond on that day. We require at least three trades in the bond on a given date for the measure to be valid. We aggregate the interquartile range to the bond-month level by computing the volume-weighted average of the daily measure.
Downgrade	Dummy variable that equals one if the bond is downgraded from investment to non-investment grade within plus and minus two months from the current month, and zero otherwise.
Investment grade	Dummy variable that equals one if the bond is an investment-grade bond, and zero otherwise. An investment-grade bond is a bond whose credit rating is equivalent to BBB- or better. The credit ratings are from Moody's, S&P, and Fitch. If the ratings are available from all three agencies, the middle rating is used. If the ratings are available from two agencies, the worse rating is used.
ln(1 + bond age)	Natural log of 1 plus the bond age in years. Age is the time between the offering date and a particular date.

Variable Definitions and Data Sources [continued]

Variable	Description
ln(1 + bond issue size)	Natural log of 1 plus bond issue size in \$1,000. Issue size is the offering amount as reported by Mergent FISD.
ln(1 + bond maturity)	Natural log of 1 plus maturity in years. For each bond, maturity is the time between a particular date and the bond's maturity date.
Mutual fund ownership	Ownership in a particular bond of all taxable bond mutual funds in the Morningstar database, as of the previous report date, computed as a fraction of the bond issue size.
Return	Current month return, calculated as the percentage change in volume-weighted average price (VWAP) from the last day on which there are transactions in the previous month to the last day on which there are transactions in the current month. Only returns calculated from VWAP that lie in the last 10 days of each month are used. In case, there are no transactions during the last 10 days of the previous month but there are transactions in the first 10 days of the current month, the previous month VWAP is replaced by the VWAP from the first day on which there are transactions in the current month. We include the accrued interest and the coupon payments, if any, and compute the monthly bond return in month t as: $$r_{j,t} = \frac{P_{j,t} + AI_{j,t} + C_{j,t}}{P_{j,t-1} + AI_{j,t-1}} - 1,$$ where $P_{j,t}$ denotes the volume-weighted transaction price, $AI_{j,t}$ denotes the accrued interest, and $C_{j,t}$ is the coupon payment. Duration-adjusted bond return is the difference between a bond's return, $r_{j,t}$, and its duration-matched risk-free return.
Upgrade	Dummy variable that equals one if the bond is upgraded from non-investment to investment grade within plus and minus two months from the current month, and zero otherwise.

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Figure 1: LS Funds' Liquidity Supply over Time

This figure displays the coefficients β_k for $k \in \{2010, \ldots, 2019\} \setminus \{2014\}$ from the regression:

$$Fund\,Position\,Change_{i,j,t} = \beta_0 + \beta_1\, \mathbb{1}[QE] + \sum_{k=2010 \setminus \{2014\}}^{2019} \beta_k\, \mathbb{1}[Year = k] \times \mathbb{1}[QE] + \theta_1'\, \mathbf{M_{j,t}} + \theta_2'\, \mathbf{M_{i,t}} + \eta_j \times \lambda_q + \varepsilon_{i,j,t}\,.$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[Year = k]$ is an indicator that is one in year k. Due to noisy data in the pre-leverage ratio period, we group 2012 and 2013 into one indicator variable, which smooths the point estimate over the two years. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December), and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, effective duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of period $t-1$. $\eta_j \times \lambda_q$ represents bond-year-quarter fixed effects. Standard errors are double-clustered at the fund family and year-quarter level. The gray shaded areas represent the 90% confidence intervals. The regression sample is restricted to LS funds and investment-grade bonds.

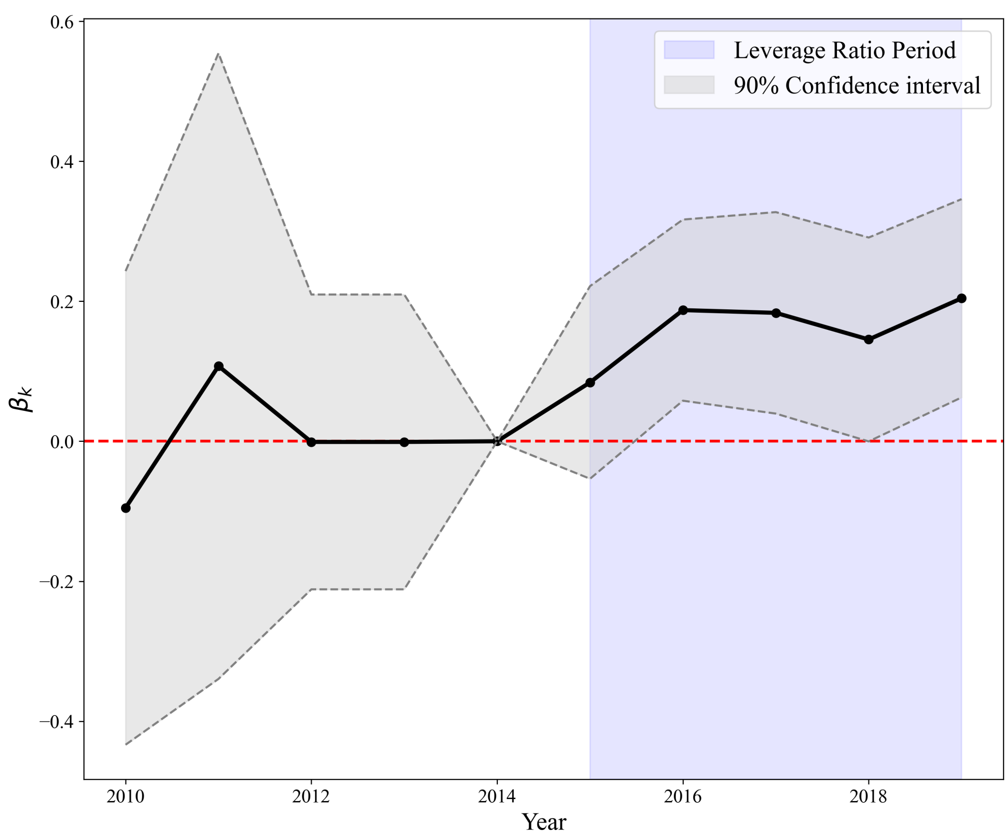

Figure 2: LS Funds' Performance over Time

This figure displays the coefficients β_k for $k \in \{2010, \ldots, 2019\} \setminus \{2014\}$ from the regression:

$$Fund\,Alpha_{i,t} = \beta_0 + \beta_1\, \mathbb{1}[LS\,Fund] + \sum_{k=2010 \setminus \{2014\}}^{2019} \beta_k\, \mathbb{1}[Year = k] \times \mathbb{1}[LS\,Fund]$$
$$+ \gamma' \mathbf{M_{i,t}} + \eta_c \times \lambda_q + \epsilon_{i,t}\,.$$

The dependent variable, $Fund\,Alpha_{i,t}$, represents the alpha (in percent) of fund i in month t, and is calculated using Chen and Qin (2017)'s four-factor model. $\mathbb{1}[LS\,Fund]$ is an indicator that is one if the fund is defined as liquidity-supplying, and zero otherwise. $\mathbb{1}[Year = k]$ is an indicator that is one in year k. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). All controls are as of the end of period $t-1$. $\eta_c \times \lambda_q$ represents fund category-quarter fixed effects. Standard errors are double-clustered at the fund family and year-quarter levels. The gray shaded areas represent 90% confidence intervals. The regression sample is restricted to IG-focused funds.

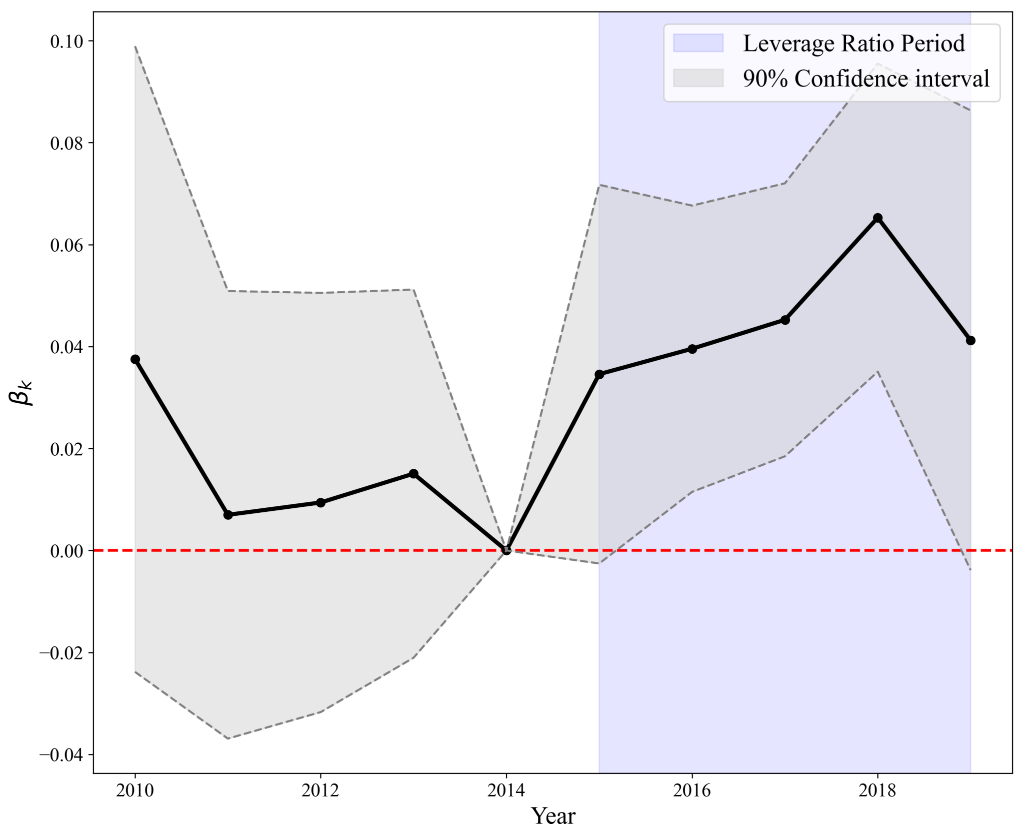

Table 1
Summary Statistics

This table presents summary statistics for fund-level (Panel A), position-level (Panel B), and bond-level (Panel C) variables. The data on fund holdings and characteristics are from Morningstar, Morningstar Direct, and CRSP. The data on bond characteristics are from Mergent FISD. The data on corporate bond transactions, which we use to calculate bond prices and returns, are from FINRA's Regulatory TRACE. The main sample covers the period from 1/2010 to 12/2019. The fund sample includes only open-ended taxable bond mutual funds that hold at least 20% of the total net assets under management (TNA) in corporate bonds. All share classes with the same master portfolio count as one fund, and the number of unique funds is 1,167. The bond sample includes only non-puttable U.S. Corporate Debentures and U.S. Corporate Bank Notes (bond type CDEB or USBN) held by at least one fund on the latest report date, and the number of unique bond CUSIPs is 20,436. The position sample includes only the positions of sample funds in sample bonds. Detailed variable definitions are in the Appendix.

Panel A: Fund-Level Variables

	Main Sample (58,040 Fund-Periods)					Mean by Fund Type (15,917 / 42,123 Fund-Periods)	
Variable	Mean	Std	10%	50%	90%	LS Funds	Non-LS Funds
Total net assets ($ Mil.)	2518.40	9698.86	42.30	542.90	5166.31	3262.46	2238.09
Portfolio avg. bond issue size	1059.64	291.69	710.43	1016.84	1467.23	1048.58	1063.76
Portfolio avg. bond age (year)	3.81	1.04	2.60	3.65	5.26	3.96	3.75
Portfolio avg. credit rating (1 = AAA)	10.11	3.95	5.00	9.00	16.00	9.76	10.24
Portfolio average duration (year)	5.46	2.46	2.59	4.90	8.94	5.09	5.60
Portfolio avg. coupon rate	5.35	1.63	3.39	5.19	7.60	5.14	5.43
Corporate bonds as % of portfolio	55.11	26.22	23.56	48.86	92.44	54.58	55.30
Government bonds as % of portfolio	14.89	17.13	0.00	8.67	42.10	15.16	14.79
Cash as % of portfolio	8.05	9.75	0.44	5.74	20.03	8.89	7.73
Flow (%)	0.70	4.36	-3.12	0.09	5.08	1.21	0.50
Alpha (%)	-0.04	0.55	-0.53	-0.02	0.44	-0.03	-0.05
Fund age	2.43	0.85	1.15	2.65	3.38	2.24	2.51
Broker affiliation	0.09	0.29	0.00	0.00	0.00	0.09	0.09
Turnover (%)	16.28	17.09	3.44	11.24	33.20	16.94	16.04
LS score	-0.05	0.26	-0.37	-0.04	0.26	0.05	-0.09

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Table 1 (continued)

Panel B: Position-Level Variables

	All Bonds (10,610,677 Fund-Bond-Periods)					Mean by Fund Type (3,302,574 LS Bond-Periods 7,308,103 Non-LS Bond-Periods)	
Variable	Mean	Std	10%	50%	90%	LS Funds	Non-LS Funds
Fund pos. change / TNA_{t-1} (bp)	0.23	4.47	0.00	0.00	0.00	0.30	0.20
IG Bonds:	0.17	3.73	0.00	0.00	0.00	0.20	0.16
HY bonds:	0.33	5.48	0.00	0.00	0.78	0.61	0.26
Trade return	-0.01	0.15	-0.10	0.00	0.07	0.00	-0.01
IG Bonds:	0.00	0.11	-0.04	0.00	0.04	0.00	0.00
HY bonds:	-0.02	0.20	-0.22	0.00	0.15	-0.02	-0.02

Panel C: Bond-Level Variables

	Main Sample (908,354 Bond-Periods)					Mean by Bond Type (156,493 Constr. Bond-Periods 751,861 Unconstr. Bond-Periods)	
Variable	Mean	Std	10%	50%	90%	Constrained	Unconstrained
Bond rating	10.03	5.22	5.00	9.00	17.00	10.47	9.94
Bond age (year)	5.40	4.13	1.07	4.21	10.38	3.76	5.74
Bond maturity (year)	9.96	9.12	2.54	6.96	25.77	10.62	9.82
Bond issue size ($ mn)	687.30	524.77	249.36	499.40	1281.48	783.79	667.23
Investment grade	0.71	0.46	0.00	1.00	1.00	0.64	0.72
Upgrade	0.01	0.10	0.00	0.00	0.00	0.01	0.01
Downgrade	0.01	0.09	0.00	0.00	0.00	0.01	0.01
Mutual fund ownership	0.10	0.09	0.01	0.07	0.22	0.12	0.09
Flow-induced fire sales (FIFS)	0.03	0.08	0.00	0.00	0.08	0.05	0.03
Bond Illiquidity							
Interquartile range (bp)	46.75	49.17	7.89	30.20	108.19	47.81	46.49
Imputed roundtrip cost (bp)	16.78	25.49	0.40	8.16	40.49	14.43	17.27
Effective bid-ask spread (bp)	55.35	69.53	6.99	31.96	131.95	44.18	57.88

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Table 1 (continued)

Panel C: Bond-Level Variables

	Main Sample (908,354 Bond-Periods)					Mean by Bond Type (156,493 Constr. Bond-Periods 751,861 Unconstr. Bond-Periods)	
Variable	Mean	Std	10%	50%	90%	Constrained	Unconstrained
Bond Illiquidity							
First principal component	-10.17	70.68	-67.39	-33.80	78.38	-17.79	-8.28
IG Bonds:	-12.57	70.35	-68.86	-35.84	74.52	-20.18	-10.85
HY Bonds:	-12.79	65.27	-61.76	-36.13	69.01	-12.53	-0.27
Bond return (%)	-0.20	2.10	-2.28	-0.13	1.99	-0.23	-0.19
Bond return (duration-adjusted, %)	0.09	3.32	-0.52	0.08	0.79	0.04	0.11
Constrained dealers' inventory holdings (%)							
All bonds	0.63	1.39	0.01	0.19	1.65	-	-
Constrained bonds	2.30	2.44	1.02	1.66	4.08	-	-
Unconstrained bonds	0.21	0.24	0.0	0.10	0.61	-	-

Table 2
LS Funds' Trading in Investment-Grade Bonds across Regulatory Periods

This table displays estimates for the regression:

$$Fund\,Position\,Change_{i,j,t} = \beta_0 + \beta_1\,\mathbb{1}[QE] + \beta_2\,\mathbb{1}[QE] \times \mathbb{1}[LR\ Period] + \theta_1'\,\mathbf{M_{j,t}} + \theta_2'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,.$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December), and zero otherwise. $\mathbf{1}[LR\ Period]$ is an indicator that equals one during the leverage ratio period (01/2015-12/2019), and zero otherwise. $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample includes only positions of LS funds in investment-grade bonds. Column 1 considers only the leverage ratio period. Column 2 considers only the pre-leverage ratio period. Column 3 considers all periods. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Leverage Ratio	Pre-Leverage Ratio	All
	(1)	(2)	(3)
$\mathbb{1}[QE]$	**0.060****	-0.032	-0.097
	(0.026)	(0.078)	(0.068)
$\mathbb{1}[QE] \times \mathbb{1}[LR\ Period]$			**0.185****
			(0.075)
Observations	1,411,265	491,668	1,902,933
R-squared	0.11	0.15	0.13
Bond x Year FE	✓	✓	✓
Bond controls	✓	✓	✓
Fund controls	✓	✓	✓

Table 3
Fund Liquidity Provision across Regulatory Periods - Placebos

This table displays estimates for the regression:

$$\begin{aligned} Fund\,Position\,Change_{i,j,t} &= \beta_0 + \beta_1\,\mathbb{1}[QE] + \beta_2\,\mathbb{1}[QE] \times \mathbb{1}[LR\ Period] \\ &\quad + \boldsymbol{\theta_1'}\,\mathbf{M_{j,t}} + \boldsymbol{\theta_2'}\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,. \end{aligned}$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December), and zero otherwise. $\mathbf{1}[LR\ Period]$ is an indicator that equals one for the leverage ratio period (01/2015-12/2019), and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. Columns 1-3 show the estimates for non-LS funds and investment-grade bonds, while columns 4-6 show the estimates for LS funds and high-yield bonds. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Fund Type	Non-LS Funds			LS Funds		
Bond Type	Investment-Grade			High-Yield		
Regulatory Period	LR	Pre-LR	All	LR	Pre-LR	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.040	0.118	0.079	0.183*	0.330*	0.273*
	(0.031)	(0.085)	(0.076)	(0.105)	(0.183)	(0.161)
$\mathbb{1}[QE] \times \mathbb{1}[LR\ Period]$			-0.015			-0.041
			(0.082)			(0.165)
Observations	1,896,897	1,363,698	3,260,595	446,570	266,849	713,419
R-squared	0.10	0.11	0.11	0.12	0.15	0.14
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond controls	✓	✓	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓	✓	✓

Table 4
LS Funds' Liquidity Provision and Investment-Grade Bonds' Exposure to Leverage Constraints

This table displays estimates for the regression:

$$\begin{aligned} Fund\,Position\,Change_{i,j,t} = & \beta_0 + \beta_1\,\mathbb{1}[Constr.\,Bond_{j,t}] + \beta_2\,\mathbb{1}[LS\,Fund_{i,t}] + \beta_3\,\mathbb{1}[QE] \\ & + \beta_4\,\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond_{j,t}] + \beta_5\,\mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr.\,Bond_{j,t}] \\ & + \beta_6\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] + \beta_7\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr\,Bond_{j,t}] \\ & + \theta_{\mathbf{1}}'\,\mathbf{M_{j,t}} + \theta_{\mathbf{2}}'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,. \end{aligned}$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t relative to the previous period fund's TNA ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December), and zero otherwise. $\mathbb{1}[LS\,Fund]$ is an indicator that is one if the fund is defined as a liquidity-supplying fund, and zero otherwise. $\mathbb{1}[Constr.\,Bond]$ is an indicator that equals one if the bond is defined as constrained in period t, and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. In column 4, the constrained bond indicators are constructed by considering separately the inventory holdings of two groups of bank-affiliated dealers with distance to the regulatory minimum capital above and below the volume-weighted median. $\mathbf{1}[Constr.\,Bond\,|\,\Delta\,LR\,Min.\,>50\%]$ is an indicator that equals one if the bond is defined as constrained in period t based on the inventories of bank-affiliated dealers with above-median distance to the regulatory minimum capital. $\mathbf{1}[Constr.\,Bond\,|\,\Delta\,LR\,Min.\,\leq 50\%]$ is an indicator that equals one if the bond is defined as constrained in period t based on the inventories of bank-affiliated dealers with below-median distance to the regulatory minimum capital. The sample includes only positions in investment-grade bonds during the leverage ratio period. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

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Table 4 - continued

Regulatory Period	Leverage Ratio Period			
Fund Type	LS	Non-LS	All	All
	(1)	(2)	(3)	(4)
$\mathbf{1}[QE]$	0.041 (0.024)	0.048 (0.029)	0.032 (0.029)	0.027 (0.030)
$\mathbf{1}[Constr.\,Bond]$	-0.004 (0.020)	-0.087*** (0.028)	-0.081* (0.041)	
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond]$	**0.096**** **(0.039)**	-0.033 (0.052)	-0.016 (0.050)	
$\mathbf{1}[LS - Fund]$			0.034 (0.030)	0.065* (0.033)
$\mathbf{1}[QE] \times \mathbf{1}[LS - Fund]$			0.040* (0.022)	0.041* (0.023)
$\mathbf{1}[Constr.\,Bond] \times \mathbf{1}[LS - Fund]$			0.069 (0.074)	
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond] \times \mathbf{1}[LS - Fund]$			**0.089**** **(0.039)**	
$\mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. \leq 50\%]$				0.243*** (0.067)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. \leq 50\%]$				-0.026 (0.086)
$\mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. > 50\%]$				0.104** (0.048)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. > 50\%]$				0.039 (0.064)
$\mathbf{1}[Constr.\,Bond \,\vert\, \Delta LR\, Min. \leq 50\%] \times \mathbf{1}[LS - Fund]$				-0.130 (0.104)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. \leq 50\%]$ $\times\, \mathbf{1}[LS - Fund]$				**0.154**** **(0.069)**
$\mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. > 50\%] \times \mathbf{1}[LS - Fund]$				-0.057 (0.077)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond \,\vert\, \Delta\, LR\, Min. > 50\%]$ $\times\, \mathbf{1}[LS - Fund]$				0.055 (0.048)
Observations	1,411,265	1,896,897	3,309,551	3,309,551
R-squared	0.11	0.10	0.09	0.09
Bond x Year FE	✓	✓	✓	✓
Bond controls	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓

Table 5
LS Funds' Trade Returns in Investment Grade Bonds

This table displays estimates for the regression:

$$
\begin{aligned}
Trade\ Return_{i,j,t} &= \beta_0 + \beta_1\, \mathbb{1}[Constr.\, Bond_{j,t}] + \beta_2\, \mathbb{1}[LR - Period] + \beta_3\, \mathbb{1}[QE] \\
&+ \beta_4\, \mathbb{1}[QE] \times \mathbb{1}[Constr.\, Bond_{j,t}] + \beta_5\, \mathbb{1}[LR - Period] \times \mathbb{1}[Constr.\, Bond_{j,t}] \\
&+ \beta_6\, \mathbb{1}[QE] \times \mathbb{1}[LR - Period] + \beta_7\, \mathbb{1}[QE] \times \mathbb{1}[LR - Period] \times \mathbb{1}[Constr\, Bond_{j,t}] \\
&+ \theta_1'\, \mathbf{M_{j,t}} + \theta_2'\, \mathbf{M_{i,t}} + \eta_s \times \lambda_q + \varepsilon_{i,j,t}\,.
\end{aligned}
$$

The dependent variable, $Trade\ Return_{i,j,t}$, is the change in position of fund i in bond j from period $t-1$ to t multiplied by the abnormal return of bond j from period t to $t+1$ (both denoted in basis points). For a given bond, the abnormal return is calculated as the difference between the bond's duration-adjusted return and the bond market model return, where the market factor is the bond's credit-rating-matched index. The factor loading is estimated over a 36-month rolling window. The sample includes only strictly positive position changes of LS funds in investment-grade bonds. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December), and zero otherwise. $\mathbf{1}[LR\ Period]$ is an indicator that equals one during the leverage ratio period (01/2015-12/2019), and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_s \times \lambda_q$ represents issuer times year-quarter fixed effects. Standard errors, double-clustered at the fund family-issuer and year-quarter levels, are in parentheses. Observations are weighted by the change in position of fund i in bond j from period $t-1$ to t. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Bond Type	Investment-Grade			
Regulatory Period	LR	Pre-LR	All	All
	(1)	(2)	(3)	(4)
$\mathbf{1}[QE]$	**0.044***	-0.059*	-0.056*	-0.047
	(0.024)	(0.031)	(0.032)	(0.030)
$\mathbf{1}[QE] \times \mathbf{1}[LR - Period]$			**0.099****	0.088**
			(0.040)	(0.039)
$\mathbf{1}[Constr.\, Bond]$				0.024
				(0.016)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\, Bond]$				-0.033
				(0.020)
$\mathbf{1}[LR\ Period] \times \mathbf{1}[Constr.\, Bond]$				-0.020
				(0.017)
$\mathbf{1}[QE] \times \mathbf{1}[LR - Period]$ $\times\ \mathbf{1}[Constr.\, Bond]$				**0.042***
				(0.022)
Observations	90,741	17,515	108,256	108,256
R-squared	0.55	0.60	0.57	0.57
Issuer x Year-Quarter FE	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓

Table 6
Fund Performance by Regulatory Period

This table reports OLS estimates for panel regressions of fund alpha (in percent) on an indicator for liquidity-supplying funds and its interaction with an indicator for the leverage ratio period. For each fund i in month t, the dependent variable, alpha, is calculated using Chen and Qin (2017) four-factor model:

$$R_{i,t} - R_{f,t} = \alpha + \beta_{i,STK} \times STK_t + \beta_{i,BOND} \times BOND_t + \beta_{i,DEF} \times DEF_t + \beta_{i,OPTION} \times OPTION_t\,.$$

The dependent variable, $R_{i,t} - R_{f,t}$, represents the return of fund i in month t in excess of the risk-free rate. STK_t is the excess return on the CRSP value-weighted stock index, $BOND_t$ is the excess return on the U.S. aggregate bond index, DEF_t is the return spread between the high-yield bond index and the intermediate government bond index, and $OPTION_t$ is the return spread between the GNMA mortgage-backed security index and the intermediate government bond index. All bond indices are from Bank of America Merrill Lynch, and are downloaded from DataStream. The parameters, $\beta_{i,STK}$, $\beta_{i,BOND}$, $\beta_{i,DEF}$, $\beta_{i,OPTION}$ are estimated on a rolling window that goes from months $t-24$ to $t-1$ for alpha in month t. $\mathbb{1}[LS\,Fund]$ is an indicator that is one if the fund is defined as liquidity supplying, and zero otherwise. $\mathbb{1}[LR\,Period]$ is an indicator that is one during the leverage ratio period (01/2015 - 12/2019), and zero otherwise. All columns include Morningstar's fund category-month fixed effects, and fund controls, including lagged flow, lagged alpha, broker affiliation dummy, time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age), and time-varying fund characteristics (age, size, family size, and average maximum rear load). All controls are as of the end of the previous period. In columns 2 and 4, we exclude the Taper Tantrum period, which ranges from May to September 2013. Standard errors, double-clustered at the fund family and year-month levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Fund Specialization	IG-Focused Funds		HY-Focused Funds	
	(1)	(2)	(3)	(4)
$\mathbb{1}[LS\,Fund]$	-0.001	-0.003	0.027	0.036*
	(0.009)	(0.010)	(0.018)	(0.019)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[LR\,Period]$	**0.022****	**0.024****	-0.017	-0.025
	(0.011)	**(0.011)**	(0.020)	(0.021)
Observations	41,694	39,643	25,117	23,849
R-squared	0.44	0.44	0.41	0.41
Fund cat. x Period FE	✓	✓	✓	✓
Taper period excluded	–	✓	–	✓
Fund controls	✓	✓	✓	✓

Table 7
Within-Quarter Variation in Investment-Grade Funds' Performance

This table reports OLS estimates for panel regressions of fund alpha (in percent) in the first month vs. the other months of a quarter on an indicator for liquidity-supplying funds and its interaction with an indicator for the leverage ratio period. For each fund i in month t, the dependent variable, alpha, is calculated using Chen and Qin (2017) four-factor model:

$$R_{i,t} - R_{f,t} = \alpha + \left[\beta_{i,STK} \times STK_t + \beta_{i,BOND} \times BOND_t + \beta_{i,DEF} \times DEF_t + \beta_{i,OPTION} \times OPTION_t\right].$$

The dependent variable, $R_{i,t} - R_{f,t}$, represents the return of fund i in month t in excess of the risk-free rate. STK_t is the excess return on the CRSP value-weighted stock index, $BOND_t$ is the excess return on the U.S. aggregate bond index, DEF_t is the return spread between the high-yield bond index and the intermediate government bond index, and $OPTION$ is the return spread between the GNMA mortgage-backed security index and the intermediate government bond index. All bond indices are from Bank of America Merrill Lynch, and are downloaded from DataStream. The parameters, $\beta_{i,STK}$, $\beta_{i,BOND}$, $\beta_{i,DEF}$, $\beta_{i,OPTION}$ are estimated on a rolling window from months $t-24$ to $t-1$ for alpha in month t. $\mathbb{1}[LSFund]$ is an indicator that is one if the fund is defined as liquidity supplying, and zero otherwise. $\mathbb{1}[LR\ Period]$ is an indicator that is one during the leverage ratio period (01/2015 - 12/2019), and zero otherwise. The sample includes only investment-grade focused funds. All columns include Morningstar's fund category-month fixed effects, and fund controls, including lagged flow, lagged alpha, broker affiliation dummy, time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age), and time-varying fund characteristics (age, size, family size, and average maximum rear load). All controls are as of the end of the previous period. Standard errors, double-clustered at the fund family and year-month levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Month of Quarter	Month 1	Months 2 & 3
	(1)	(2)
$\mathbb{1}[LS\,Fund]$	0.008	-0.007
	(0.012)	(0.011)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[LR\,Period]$	**0.035****	0.016
	(0.015)	(0.012)
Observations	13,329	28,365
R-squared	0.44	0.44
Fund cat. x Period FE	✓	✓
Fund controls	✓	✓

Table 8
Bank-Affiliated Funds' Liquidity Provision and Performance

This table reports OLS regression estimates for the relationships between fund liquidity supply, fund performance, and bank-affiliation status during the leverage ratio period (01/2015 - 12/2019). In column 1, the observations are at the fund-bond-period level, and the sample includes only investment-grade bonds and LS funds. The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), expressed in basis points. In column 2, the observations are at the fund-month level, and the sample includes all investment-grade focused funds. The dependent variable, $\alpha_{i,t}$, represents the alpha of fund i in month t, estimated as in Table 7. In both columns, variables are defined as follows. $\mathbb{1}[Bank-aff.]$ is an indicator that is one if either the fund management company or the fund advisor is affiliated with a constrained bank dealer and zero otherwise. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December) and zero otherwise. $\mathbb{1}[Constr.\,Bond]$ is an indicator that equals one if the bond is defined as constrained in month t and zero otherwise. $\mathbb{1}[LS-Fund]$ is an indicator that is one if the fund is defined as liquidity-supplying and zero otherwise. Fund controls include lagged flow, broker affiliation dummy, time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age), and time-varying fund characteristics (age, size, family size, and average maximum rear load). Bond controls include bond age, bond maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of period $t-1$. Column 1 includes bond-year fixed effects, bond controls, and fund controls. Column 2 includes fund category-period fixed effects and fund controls. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

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Table 8 - continued

Dependent Variable	Fund Position Change	Fund Alpha
	(1)	(2)
$\mathbb{1}[QE]$	0.051^{*}	
	(0.026)	
$\mathbb{1}[Constr.\,Bond]$	0.006	
	(0.022)	
$\mathbb{1}[Bank-aff.]$	-0.134	-0.007
	(0.111)	(0.009)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond]$	**0.095****	
	(0.039)	
$\mathbb{1}[QE] \times \mathbb{1}[Bank-aff.]$	-0.149	
	(0.143)	
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Bank-aff.]$	-0.109	
	(0.076)	
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Bank-aff.]$	0.044	
	(0.106)	
$\mathbb{1}[LS\,Fund]$		0.010^{*}
		(0.006)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Bank-aff.]$		**0.032****
		(0.015)
Observations	1,399,889	22,453
R-squared	0.11	0.42
Bond x Year FE	✓	
Fund cat. × Period FE		✓
Bond controls	✓	
Fund controls	✓	✓

Table 9
Investment-Grade Funds' Liquidity Provision, Performance, and Flows

This table reports OLS estimates for panel regressions of an indicator of whether a fund pursues liquidity supplying strategies on the average performance of all LS funds and the fund's flows:

$$\mathbb{1}[LS\_score_{i,t} > 0] = \beta_0 + \beta_1\, LS\,Fund\,Performance_{t-1,t-12} + \beta_2\, Fund\,Flow_{i,t-1,t-12} \\ + \beta_3\, \mathbb{1}[Bank - aff._{i,t}] + \gamma'\, \mathbf{M_{i,t}} + \eta_c + \epsilon_{i,t}\,.$$

The dependent variable, $\mathbb{1}[LS\_score_{i,t} > 0]$, is an indicator that equals one if fund i has a positive LS_score in period t and zero otherwise. $LS\,Fund\,Performance_{t-1,t-12}$ denotes the average performance of all LS funds over the past 12 months, measured as the rolling average fund alpha in percent. $Fund\,Flow_{i,t-1,t-12}$ denotes the average flows in percent of fund i over the past 12 months. $\mathbb{1}[Bank - aff.]$ is an indicator that equals one if either the fund management company or the fund advisor is affiliated with a constrained bank dealer, and zero otherwise. $\mathbf{M_{i,t}}$ refers to fund-level controls, which include broker affiliation dummy, time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age), and time-varying fund characteristics (age, size, family size, and average maximum rear load). All controls are as of the end of the previous period. η_c refers to fund category fixed effects. Column 1 considers the leverage ratio period (01/2015 - 12/2019). Column 2 considers the pre-leverage ratio period (01/2010 - 12/2014). Column 3 considers all periods. The sample includes only investment-grade focused funds. Standard errors, double-clustered at the fund family and year-month levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	LR	Pre-LR	All
	(1)	(2)	(3)
$LS\,Fund\,Performance_{t-1,t-12}$	**0.511****	-0.052	-0.040
	(0.243)	(0.103)	(0.104)
$Fund\ Flow_{i,t-1,t-12}$	0.328**	-0.056	-0.092
	(0.134)	(0.133)	(0.128)
$\mathbb{1}[Bank - aff.]$	-0.006	-0.016	-0.010
	(0.024)	(0.019)	(0.016)
$\mathbb{1}[LR\ Period] \times LS\,Fund\,Performance_{t-1,t-12}$			**0.542****
			(0.255)
$\mathbb{1}[LR\ Period] \times Fund\ Flow_{i,t-1,t-12}$			**0.456****
			(0.182)
Observations	18,233	15,264	33,497
R-squared	0.02	0.01	0.01
Fund cat. FE	✓	✓	✓
Fund controls	✓	✓	✓

Table 10
Fund Liquidity Supply Relative to Dealer Inventories

This table reports liquidity-supplying funds' volume-weighted average monthly net liquidity supply relative to the dealer sector's mean inventories in constrained and unconstrained investment-grade bonds during positive inventory cycles. In each month from January 2010 to December 2019, the net liquidity supply in a particular bond is defined as the dollar par amount of that bond purchased minus the dollar par amount of that bond sold by all LS funds divided by the dealer sector's mean inventory. The resulting ratio is reported in percent. Volume-weighted (across-bond) averages of the net liquidity supply are computed using weighted linear regressions in which the net liquidity supply is regressed on two indicator variables that differentiate constrained from unconstrained investment-grade bonds (top versus bottom quintiles of constrained dealers' inventory holdings (Equation 2), ignoring bonds with zero inventory holdings due to not being traded in the first 20 days of a given month) and quarter-end months (March, June, September, December) from non-quarter-end months. We use a bond's monthly total trading volumes by either liquidity-supplying funds (Panel A) or all mutual funds (Panel B) as the weights. Standard errors, double-clustered at the bond and year-month levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Panel A: Bonds Traded by Liquidity-Supplying Funds

	Pre-Leverage Ratio		Leverage Ratio	
Bond	Non-Quarter-End Month	Quarter-End Month	Non-Quarter-End Month	Quarter-End Month
Constrained	7.78**	**6.14***	3.00	**14.75*****
	(2.94)	**(3.08)**	(2.09)	**(3.81)**
Unconstrained	4.01	0.21	-1.64	-5.62
	(2.95)	(4.30)	(2.77)	(6.19)

Panel B: Bonds Traded by All Mutual Funds

	Pre-Leverage Ratio		Leverage Ratio	
Bond	Non-Quarter-End Month	Quarter-End Month	Non-Quarter-End Month	Quarter-End Month
Constrained	4.22***	**1.29**	0.59	**9.02*****
	(1.47)	**(1.37)**	(1.51)	**(3.07)**
Unconstrained	-0.76	-1.35	-3.05	-8.19
	(2.60)	(1.70)	(2.45)	(5.19)

Table 11
Bond Illiquidity, Returns, and Outflows from the Mutual Fund Industry

This table reports OLS estimates for the following panel regression:

$$\begin{aligned} Y_{j,t} = {} & \beta_0 + \beta_1\, \mathbb{1}[Constr.\,Bond_{j,t}] + \beta_2\, \mathbb{1}[Flow_t \in [0\%, 20\%]] + \beta_3\, \mathbb{1}[Constr.\,Bond_{j,t}] \times \mathbb{1}[Flow_t \in [0\%, 20\%]] \\ & + \beta_4\, \mathbb{1}[Constr.\,Bond_{j,t}] \times \mathbb{1}[LR\,Period] + \beta_5\, \mathbb{1}[Flow_t \in [0\%, 20\%]] \times \mathbb{1}[LR\,Period] \\ & + \beta_6\, \mathbb{1}[Constr.\,Bond_{j,t}] \times \mathbb{1}[Flow_t \in [0\%, 20\%]] \times \mathbb{1}[LR\,Period] + \beta_7\, Agg.\,Flows_t + \beta_8\, Matched\,Ret_{j,t} \\ & + \gamma'\, \mathbf{M_{j,t}} + \eta_s + \lambda_q + \varepsilon_{j,t}\,. \end{aligned}$$

The dependent variables, $Y_{j,t}$, are the monthly average illiquidity (column 1-3) and the monthly percentage duration-adjusted return (column 4-6) of bond j in month t. The monthly average illiquidity is the equally-weighted average of daily illiquidity across all trading days in a given month. We proxy for daily bond illiquidity by the first principal component of the three individual liquidity measures: effective bid-ask spread, imputed round-trip cost, and the interquartile range measure. We define the duration-adjusted return as the difference between a bond's return and its duration-matched risk-free return following van Binsbergen et al. (2024). $\mathbb{1}[Constr.\,Bond_{j,t}]$ is an indicator that is one if the bond is defined as constrained during month t, and zero otherwise. $\mathbb{1}[Flow \in [0\%, 20\%]]$ is an indicator that is one if the aggregate fund flows in month t are in the bottom 20 percent of the sample and zero otherwise. $\mathbb{1}[LR\,Period]$ is an indicator that is one in the leverage ratio period (01/2015 - 12/2019) and zero otherwise. $\mathbf{M_{j,t}}$ denotes a vector of bond-level controls, including the maturity, issue size, age, flow-induced fire sales, as well as upgrade and downgrade indicators. $Matched\ Ret_t$ represents the bond's credit-rating-matched index return. We also include aggregate fund flows to investment-grade focused funds, computed as the sum of dollar flows across all share classes and funds, presented as a fraction of aggregate TNA at the beginning of the month. The sample includes only investment-grade bonds. η_s denotes issuer fixed effects. λ_q denotes year-quarter fixed effects. Standard errors, double-clustered by issuer and year-quarter, are in parentheses. *, **, and *** indicate statistical significance at the 10 %, 5% and 1% levels.

Dependent Variable	Average Illiquidity			Dur.-Adjusted Bond Return		
Regulatory Period	LR	Pre-LR	All	LR	Pre-LR	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[Constr.\,Bond]$	-6.350***	-9.961***	-11.759***	-0.112***	-0.145***	-0.142***
	(0.418)	(1.273)	(1.396)	(0.032)	(0.028)	(0.031)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	2.941*	-5.601	-3.915	-0.237	-0.145	-0.011
	(1.604)	(3.491)	(3.855)	(0.443)	(0.398)	(0.403)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	**3.189****	-2.607	-2.617	**-0.322*****	-0.018	-0.011
	(1.188)	(2.639)	(2.603)	**(0.093)**	(0.104)	(0.102)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[LR\,Period]$			5.894***			0.031
			(1.460)			(0.046)
$\mathbb{1}[Flow \in [0\%, 20\%)] \times \mathbb{1}[LR\,Period]$			3.585			-0.191
			(3.939)			(0.610)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Flow \in [0\%, 20\%)] \times \mathbb{1}[LR\,Period]$			**5.818***			**-0.308****
			(2.960)			**(0.142)**
Observations	221,328	159,349	380,708	303,185	227,417	530,618
R-Squared	0.45	0.48	0.45	0.12	0.16	0.13
Issuer FE	✓	✓	✓	✓	✓	✓
Year-Quarter FE	✓	✓	✓	✓	✓	✓
Bond and market controls	✓	✓	✓	✓	✓	✓

Table 12
Leverage Constraints, Bond Illiquidity, and Bond Returns around the COVID-19 Outbreak

This table reports OLS estimates for the following panel regression:

$$Y_{j,t} = \beta_1\, \mathbb{1}[March\ 2020] + \beta_2\, \mathbb{1}[Constr.\, Bond_{j,t-1}] \\ + \beta_3\, \mathbb{1}[Constr.\, Bond_{j,t-1}] \times \mathbb{1}[March\ 2020] + \beta_4\, Agg.\, Flows_t + \beta_5\, Matched\, Ret_{j,t} + \eta_s + \gamma'\, \mathbf{M_{j,t}} + \varepsilon_{j,t}\,.$$

The dependent variable, $Y_{j,t}$, represents the monthly average illiquidity (column 1) and the monthly percentage duration-adjusted return (column 2) of bond j in month t. The monthly average illiquidity is the equally-weighted average of daily illiquidity across all trading days in a given month. We proxy for daily bond illiquidity by the first principal component of the three individual liquidity measures: effective bid-ask spread, imputed round-trip cost, and the interquartile range measure. We define the duration-adjusted return as the difference between a bond's return and its duration-matched risk-free return following van Binsbergen et al. (2024). In March 2020, we end the computation of the illiquidity measure, as well as the bond return, before the announcement of the Secondary Market Corporate Credit Facility (SMCCF) by the Federal Reserve on March 23, 2020. $\mathbb{1}[March\,2020]$ is an indicator that is one during the first 22 calendar days in March 2020, and zero otherwise. $\mathbb{1}[Constrained_{j,t-1}]$ is an indicator that is one if the bond is defined as constrained during month t-1, and zero otherwise. $\mathbf{M_{j,t}}$ denotes a vector of bond-level controls including maturity, issue size, age, and flow-induced fire sales. $Matched\ Ret_t$ represents the bond's credit-rating-matched index return. We also include aggregate fund flows to investment-grade focused funds, computed as the sum of dollar flows across all share classes and funds, presented as a fraction of aggregate TNA at the beginning of the month. η_s denotes bond issuer fixed effects. The sample includes only investment-grade bonds during the period from January 2 to March 22, 2020. Standard errors, clustered by issuer, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Dependent Variable	Average Illiquidity	Duration-Adjusted Bond Return
	(1)	(2)
$\mathbb{1}[March\,2020]$	86.546***	-1.834***
	(5.833)	(0.191)
$\mathbb{1}[Constr.\, Bond_{t-1}]$	-9.253***	0.090**
	(1.666)	(0.043)
$\mathbb{1}[March\,2020] \times \mathbb{1}[Constr.\, Bond_{t-1}]$	**14.410*****	**-0.584*****
	(4.902)	**(0.112)**
Observations	10,162	13,021
R-Squared	0.52	0.83
Issuer FE	✓	✓
Bond and market controls	✓	✓

Internet Appendix

Figure A1: Non-LS Funds' Liquidity Supply over Time

This figure displays the coefficients β_k for $k \in \{2010, \ldots, 2019\} \setminus \{2014\}$ from the regression:

$$Fund\,Position\,Change_{i,j,t} = \beta_0 + \beta_1\,\mathbb{1}[QE] + \sum_{k=2010\,\setminus\,\{2014\}}^{2019} \beta_k\,\mathbb{1}[Year = k] \times \mathbb{1}[QE]$$
$$+\,\theta_1'\,\mathbf{M_{j,t}} + \theta_2'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_q + \varepsilon_{i,j,t}\,.$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position of fund i in bond j in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[Year = k]$ is an indicator that is one in year k. Due to noisy data in the pre-leverage ratio period, we group 2012 and 2013 into one indicator variable, which smooths the point estimate over the two years. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December) and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes age, maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of period $t-1$. $\eta_j \times \lambda_q$ represents bond-year-quarter fixed effects. Standard errors are double-clustered at the fund family and year-quarter levels. The gray shaded area represents the 90% confidence interval. The regression sample is restricted to Non-LS funds and investment-grade bonds.

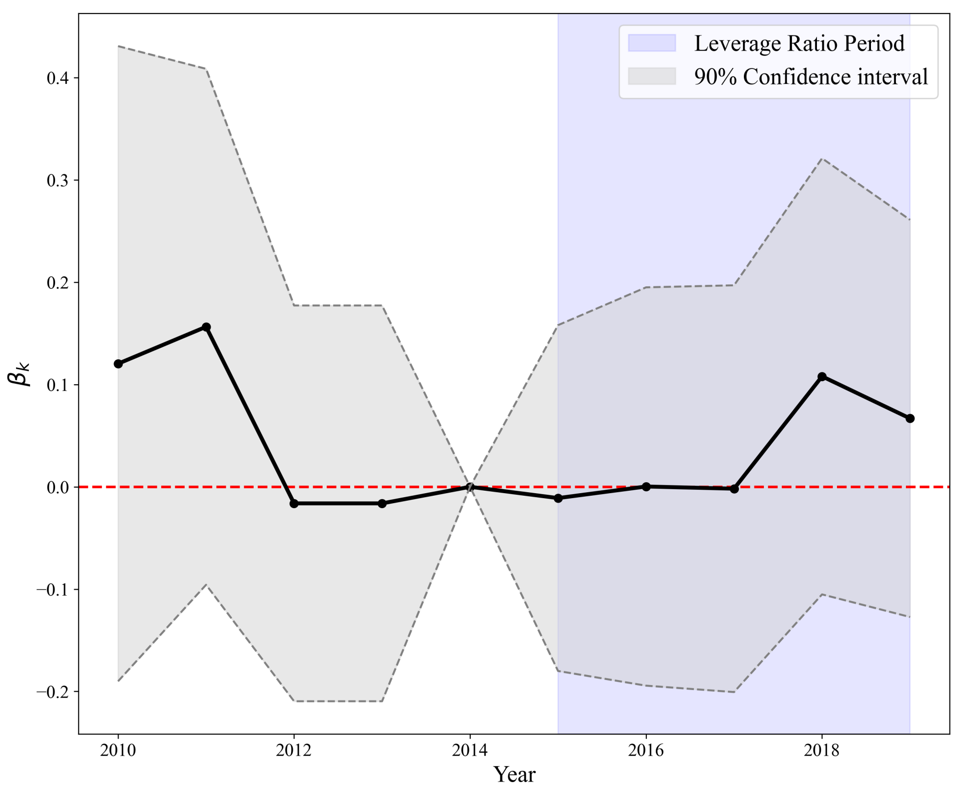

Table A1
Determinants of Bond Constrainedness

We estimate cross-sectional logistic regressions of the constrained bond indicator on the variables displayed in the table. We report the time-series average of the monthly estimates. *Bond age* and *bond maturity* are expressed in years. *Bond issue size* is expressed in \$mn. *Bond rating* represents the bond's numeric credit rating (AAA = 1). Bond illiquidity represents the average bond illiquidity during the first 20 calendar days of a month. Average p-values of the cross-sectional parameter estimates are reported in parentheses.

Average Coefficients				
$\hat{\beta}_{Age}$	$\hat{\beta}_{Maturity}$	$\hat{\beta}_{Size}$	$\hat{\beta}_{Rating}$	$\hat{\beta}_{Illiquidity}$
-0.622***	0.302***	0.176*	0.156	-0.228***
(0.000)	(0.000)	(0.059)	(0.100)	(0.008)

Table A2
Covariate Balance in the Propensity Score Matched Sample

This table displays covariate balance statistics for the one-to-one matched bond sample, distinguishing between constrained and matched unconstrained bonds. Matching is performed based on propensity score estimates computed using monthly logistic regressions of the constrained indicator on a set of bond characteristics, including *Bond age*, *Bond maturity*, *Bond issue size*, and *Bond illiquidity*. Each constrained bond in month t is matched to the unconstrained bond with the smallest absolute distance based on the estimated propensity score. We consider only unconstrained bonds in the bottom three quintiles for *Constrained Dealers' Inventory Holdings*. *Bond age* represents the logarithm of the bond's age (in years). *Bond maturity* represents the logarithm of the bond's maturity (in years). *Bond issue size* represents the logarithm of the bond's issue amount (in \$mn). *Bond rating* represents the bond's numeric credit rating (AAA = 1). *Bond illiquidity* refers to the effective bid-ask spread in basis points computed over the first 20 calendar days of the month. The last column assesses covariate balance based on the absolute value of the standardized difference in means.

	Constrained Bonds			(Matched) Unconstrained Bonds			Covariate Balance
	Obs.	Mean	Std	Obs.	Mean	Std	Std. Difference
Bond age	142,817	1.07	0.67	142,817	1.09	0.64	0.02
Bond maturity	142,817	2.08	0.72	142,817	2.08	0.76	0.01
Bond issue size	142,817	13.43	0.63	142,817	13.43	0.66	0.00
Bond rating (1 = AAA)	142,817	10.52	5.05	142,817	10.84	6.10	0.06
Bond illiquidity (bp)	142,817	40.70	50.95	142,817	40.74	53.31	0.00

Table A3
LS Funds' Liquidity Provision in Constrained Investment-Grade Bonds - Continuous Bond Constraint Measure

This table reproduces Table 4 using the continuous constrained dealers' inventory holdings measure (Equation 2), instead of the constrained bond indicator variable. The continuous bond constraint measure, *Constr. Bond* (*cont.*), is defined as the cumulative inventory changes of constrained bank-affiliated dealers in the bond calculated over the first 20 days of the month, scaled by the bond's issue size and expressed in percent. $Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. \leq 50\%}$ ($Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. > 50\%}$) is the continuous bond constraint measure calculated separately using only inventory changes of bank-affiliated dealers with below- (volume-weighted) median (above- (volume-weighted) median) distance to the regulatory minimum capital.

Regulatory Period	Leverage Ratio Period			
Fund Type	LS	Non-LS	All	All
	(1)	(2)	(3)	(4)
$\mathbf{1}[QE]$	0.018	0.054	0.038	0.037
	(0.021)	(0.036)	(0.035)	(0.035)
$Constr.\ Bond\ (cont.)$	0.072***	0.181***	0.175***	
	(0.025)	(0.036)	(0.034)	
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.)$	**0.071****	-0.024	-0.015	
	(0.025)	(0.039)	(0.038)	
$\mathbf{1}[LS-Fund]$			0.105***	0.104***
			(0.031)	(0.031)
$\mathbf{1}[QE] \times \mathbf{1}[LS-Fund]$			0.014	0.014
			(0.027)	(0.027)
$Constr.\ Bond\ (cont.) \times \mathbf{1}[LS-Fund]$			-0.094*	
			(0.050)	
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.) \times \mathbf{1}[LS-Fund]$			**0.073****	
			(0.031)	
$Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. \leq 50\%}$				0.255***
				(0.052)
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. \leq 50\%}$				-0.062
				(0.061)
$Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. > 50\%}$				0.102***
				(0.026)
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. > 50\%}$				0.029
				(0.034)
$Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. \leq 50\%} \times \mathbf{1}[LS-Fund]$				-0.127***
				(0.064)
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. \leq 50\%} \times \mathbf{1}[LS-Fund]$				**0.115****
				(0.045)
$Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. > 50\%} \times \mathbf{1}[LS-Fund]$				-0.059
				(0.041)
$\mathbf{1}[QE] \times Constr.\ Bond\ (cont.)_{\Delta\, LR\, Min. > 50\%} \times \mathbf{1}[LS-Fund]$				0.033
				(0.029)
Observations	1,411,265	1,896,897	3,309,551	3,309,551
R-squared	0.11	0.10	0.09	0.09
Bond x Year FE	✓	✓	✓	✓
Bond controls	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓

Table A4
Fund Liquidity Provision in Constrained Investment-Grade Bonds - Distinguishing Bank Dealers' Regulatory Reporting Standards

This table considers different definitions of $\mathbb{1}[Constr.\, Bond]$. Specifically, in columns 1-3, we consider only those dealers subject to the leverage ratio constraints who report the leverage ratio based on quarter averages (U.S. bank dealers and U.K. bank dealers from 2017 onwards). In columns 4-6, we consider only those dealers subject to the leverage ratio constraints who report the leverage ratio based on quarter-end snapshots (European and Japanese bank dealers and U.K. bank dealers before 2017). The table displays estimates for the regression:

$$\begin{aligned} Fund\, Position\, Change_{i,j,t} &= \beta_0 + \beta_1\, \mathbb{1}[Constr.\, Bond_{j,t}] + \beta_2\, \mathbb{1}[LS\, Fund_{i,t}] + \beta_3\, \mathbb{1}[QE] \\ &+ \beta_4\, \mathbb{1}[QE] \times \mathbb{1}[Constr.\, Bond_{j,t}] + \beta_5\, \mathbb{1}[LS\, Fund_{i,t}] \times \mathbb{1}[Constr.\, Bond_{j,t}] \\ &+ \beta_6\, \mathbb{1}[QE] \times \mathbb{1}[LS\, Fund_{i,t}] + \beta_7\, \mathbb{1}[QE] \times \mathbb{1}[LS\, Fund_{i,t}] \times \mathbb{1}[Constr\, Bond_{j,t}] \\ &+ \theta_1'\, \mathbf{M_{j,t}} + \theta_2'\, \mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,. \end{aligned}$$

The dependent variable, $Fund\, Position\, Change_{i,j,t}$, represents the change in position of fund i in bond j in period t relative to the previous period fund's TNA ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator that equals one if the period is a quarter-end month (March, June, September, December) and zero otherwise. $\mathbb{1}[LS\, Fund_{i,t}]$ is an indicator that is one if the fund is defined as a liquidity-supplying fund and zero otherwise. The constraint bond indicator, $\mathbb{1}[Constr.\, Bond_{j,t}]$, is calculated separately for each constrained dealer subset−that is, for those bank dealers reporting quarter averages and for those reporting quarter-end snapshots of the leverage ratio. Specifically, following our definition in Equation 2, we sum constrained dealers changes in inventory changes for each dealer subset. Bonds are then defined as constrained if they are in the top quintile of the group-specific distribution of cumulative inventory holdings. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes age, maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample includes only positions in investment-grade bonds during the leverage ratio period. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

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Table A4 - continued

Regulatory Period	Leverage Ratio Period					
Dealer Regulatory Reporting Standard	Quarter-Averaging			Quarter-End		
Fund Type	LS	Non-LS	All	LS	Non-LS	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{1}[QE]$	0.037	0.047	0.031	0.038	0.053*	0.035
	(0.023)	(0.029)	(0.029)	(0.023)	(0.030)	(0.029)
$\mathbb{1}[Constr.\,Bond]$	-0.022	-0.125***	-0.113**	0.029	0.007	0.026
	(0.020)	(0.028)	(0.041)	(0.024)	(0.041)	(0.056)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond]$	**0.109***	-0.000	0.015	**0.089***	-0.103	-0.087
	(0.034)	(0.036)	(0.035)	**(0.047)**	(0.072)	(0.070)
$\mathbb{1}[LS\,Fund]$			0.027			0.032
			(0.031)			(0.032)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[QE]$			0.038*			0.036
			(0.021)			(0.021)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[LS\,Fund]$			0.074			-0.023
			(0.064)			(0.094)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[LS\,Fund] \times \mathbb{1}[QE]$			**0.077***			**0.159****
			(0.039)			**(0.065)**
Observations	1,345,577	1,797,203	3,144,193	1,197,425	1,575,335	2,774,152
R-squared	0.11	0.11	0.10	0.12	0.12	0.11
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond controls	✓	✓	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓	✓	✓

Table A5
Fund Liquidity Provision in Constrained and Unconstrained Bonds - Propensity Score Matched Sample

This table reproduces the first three columns of Table 4 in the matched sample of constrained and unconstrained bonds. We restrict the sample to investment-grade bonds and the leverage ratio period (01/2015-12/2019). Propensity scores are estimated based on a monthly cross-sectional logistic regression of the constrained indicator on a set of bond characteristics, including *Bond age* and *Bond maturity*, expressed in years; *Bond issue size*, expressed in \$mn; *Bond rating*, expressed in numeric values (AAA = 1, AA+ = 2, etc.); *Bond illiquidity*, measured as the average bond illiquidity during the first 20 calendar days of a month. Each constrained bond in month t is matched, with replacement, to the unconstrained bond in month t with the smallest absolute distance based on the estimated propensity score. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Leverage Ratio Period		
Bond Type	Investment-Grade		
Fund Type	LS	Non-LS	All
	(1)	(2)	(3)
$\mathbf{1}[QE]$	0.068	0.095*	0.079*
	(0.041)	(0.047)	(0.045)
$\mathbf{1}[Constr.\,Bond]$	0.028	0.065	0.054
	(0.026)	(0.049)	(0.048)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond]$	**0.098****	-0.050	-0.034
	(0.039)	(0.069)	(0.065)
$\mathbf{1}[LS-Fund]$			0.116***
			(0.039)
$\mathbf{1}[QE] \times \mathbf{1}[LS-Fund]$			0.026
			(0.040)
$\mathbf{1}[Constr.\,Bond] \times \mathbf{1}[LS-Fund]$			-0.007
			(0.072)
$\mathbf{1}[QE] \times \mathbf{1}[Constr.\,Bond] \times \mathbf{1}[LS-Fund]$			**0.112****
			(0.047)
Observations	505,765	754,804	1,262,012
R-Squared	0.16	0.15	0.13
Bond x Year FE	✓	✓	✓
Bond Controls	✓	✓	✓
Fund Controls	✓	✓	✓

Table A6
LS Funds' Liquidity Provision in Investment-Grade Bonds - Q1-3 vs. Q4

This table displays estimates for the regression:

$$\begin{aligned} Fund\,Position\,Change_{i,j,t} &= \beta_0 + \beta_1\, \mathbb{1}[QE] + \beta_2\, \mathbb{1}[QE] \times \mathbb{1}[LR\ Period] \\ &\quad + \theta_1'\,\mathbf{M_{j,t}} + \theta_2'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,. \end{aligned}$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position in bond j of fund i in period t, relative to the fund's TNA at the end of the previous period ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator variable that equals one if the period is a quarter-end month (March, June, September, December) and zero otherwise. $\mathbf{1}[LR\ Period]$ is an indicator that is one during the leverage ratio period (01/2015-12/2019). Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes age, maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. All columns are restricted to LS funds and investment-grade bonds. Columns 1-3 restrict the sample to quarters 1, 2, and 3. Column 4-6 restrict the sample to quarter 4. Standard errors, double-clustered at the fund family and year-quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Quarter	Quarters 1-3			Quarter 4		
Regulatory Period	LR	Pre-LR	All	LR	Pre-LR	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.063	-0.007	-0.105	0.120	-0.010	-0.282*
	(0.042)	(0.079)	(0.076)	(0.058)	(0.114)	(0.139)
$\mathbb{1}[QE] \times \mathbb{1}[LR\,Period]$			**0.205****			**0.510****
			(0.086)			**(0.210)**
Observations	1,045,930	360,392	1,406,322	364,385	129,230	493,615
R-squared	0.13	0.18	0.16	0.16	0.28	0.23
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table A7
LS Fund Liquidity Provision in Constrained Investment-Grade Bonds - Q1-3 vs. Q4

This table displays estimates for the regression:

$$\begin{aligned} Fund\,Position\,Change_{i,j,t} = &\ \beta_0 + \beta_1\,\mathbb{1}[Constr.\,Bond_{j,t}] + \beta_2\,\mathbb{1}[LS\,Fund_{i,t}] + \beta_3\,\mathbb{1}[QE] \\ &+ \beta_4\,\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond_{j,t}] + \beta_5\,\mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr.\,Bond_{j,t}] \\ &+ \beta_6\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] + \beta_7\,\mathbb{1}[QE] \times \mathbb{1}[LS\,Fund_{i,t}] \times \mathbb{1}[Constr\,Bond_{j,t}] \\ &+ \theta_1'\,\mathbf{M_{j,t}} + \theta_2'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}\,. \end{aligned}$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change inbond j of fund i in period t, relative to the previous period fund TNA ($TNA_{i,t-1}$), and is expressed in basis points. $\mathbb{1}[QE]$ is an indicator variable that equals one if the period is a quarter-end month (March, June, September, December) and zero otherwise. $\mathbb{1}[LS\,Fund_{i,t}]$ is an indicator that is one if the fund is defined as a liquidity-supplying fund and zero otherwise. $\mathbb{1}[Constr.\,Bond_{j,t}]$ is an indicator variable that equals one if the bond is defined as constrained and zero otherwise. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, age, size, family size, average maximum rear load, and time-varying portfolio characteristics (% cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, average duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age). $M_{j,t}$ represents bond controls and includes age, maturity, downgrade and upgrade indicators, and the first principal component extracted from the effective bid-ask spread, the imputed round-trip cost, and the interquartile range measure. All controls are as of the end of the previous period. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample includes only positions of LS funds in investment-grade bonds. In columns 1-3, we further restrict the sample to quarters 1, 2, and 3. In columns 4-6, we restrict the sample to quarter 4. Standard errors, double-clustered at the fund family and year-quarter levels, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

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Table A7 - continued

Quarter	Quarters 1-3			Quarter 4		
Fund Type	LS	Non-LS	All	LS	Non-LS	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{1}[QE]$	0.042	0.072*	0.046	0.141*	0.217**	0.166**
	(0.039)	(0.037)	(0.033)	(0.058)	(0.053)	(0.053)
$\mathbb{1}[Constr.\,Bond]$	-0.018	-0.109**	-0.103*	0.031	-0.045	-0.045
	(0.027)	(0.045)	(0.052)	(0.031)	(0.036)	(0.036)
$\mathbf{1}[QE] \times \mathbb{1}[Constr.\,Bond]$	0.100*	-0.072	-0.058	-0.126	-0.470**	-0.402**
	(0.047)	(0.070)	(0.067)	(0.072)	(0.148)	(0.144)
$\mathbf{1}[LS-Fund]$			0.035			0.021
			(0.029)			(0.030)
$\mathbf{1}[QE] \times \mathbf{1}[LS-Fund]$			0.037			0.058
			(0.036)			(0.030)
$\mathbb{1}[Constr.\,Bond] \times \mathbf{1}[LS-Fund]$			0.075			0.069
			(0.085)			(0.054)
$\mathbf{1}[QE] \times \mathbb{1}[Constr.\,Bond] \times \mathbf{1}[LS-Fund]$			**0.147****			**0.181***
			(0.054)			**(0.071)**
Observations	1,045,930	1,411,761	2,459,166	364,385	484,231	849,988
R-squared	0.13	0.13	0.11	0.16	0.19	0.15
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table A8
Average Abnormal Returns on Bonds Purchased by LS Funds

This table reports average monthly abnormal returns of constrained and unconstrained bonds purchased by liquidity-supplying funds. Every month from January 2010 to December 2019, each fund's portfolio is split into two sub-portfolios containing only constrained and only unconstrained bonds, respectively. The fund's position holdings in each sub-portfolio are then restricted further to bond positions that are purchased in month t. All abnormal returns are as of month $t+1$. For a given bond, the abnormal return is calculated as the difference between the bond's duration-adjusted return and the bond market model return, where the market factor is the bond's credit-rating-matched index. The factor loadings are estimated over a 36-month rolling window. Average constrained and unconstrained portfolio abnormal returns are computed for each fund in each month using as weight the fund's position size, and then averaged across all funds, separately for quarter-end months (months 3,6,9,12) and non-quarter-end months. We restrict the analysis to investment-grade bonds. We report in brackets the standard deviations of the funds' portfolio abnormal returns, and for the columns with Δ in the heading, the absolute values of t-statistics for the difference in average abnormal return between constrained and unconstrained bond purchases in quarter-end months minus the difference in average abnormal return between constrained and unconstrained bond purchases in non-quarter-end months. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

	Pre-Leverage Ratio			Leverage Ratio		
Porfolio	Non-Quarter-End Month	Quarter-End Month	Δ	Non-Quarter-End Month	Quarter-End Month	Δ
Constrained	-0.22 (1.28)	-0.35 (1.29)		-0.09 (0.95)	0.55 (0.81)	
Unconstrained	-0.19 (1.03)	-0.32 (1.04)		-0.03 (0.72)	0.22 (1.21)	
Constrained - Unconstrained	**-0.03**	**-0.03**	**0.00** **(0.03)**	**-0.06**	**0.33**	**0.39**** **(2.08)**

Table A9
Bond Returns and Outflows from the Mutual Fund Industry- Propensity Score Matched Sample

This table reproduces Table 11 using the matched sample of constrained and unconstrained bonds. The sample period is 01/2010 to 12/2019. Propensity scores are estimated based on a monthly cross-sectional logistic regression of the constrained indicator on a set of bond characteristics, including *Bond age* and *Bond maturity*, expressed in years; *Bond issue size*, expressed in \$mn; *Bond rating*, expressed in numeric values (AAA = 1, AA+ = 2, etc.); *Bond illiquidity*, measured as the average bond illiquidity during the first 20 calendar days of a month. Each constrained bond in month t is matched, with replacement, to the unconstrained bond in month t with the smallest absolute distance based on the estimated propensity score. We restrict the analysis to investment-grade bonds. Standard errors, double-clustered by issuer and year-quarter, are in parentheses. *, **, and *** indicate statistical significance at the 10 %, 5% and 1% levels.

Dependent Variable	Average Illiquidity			Duration-Adjusted Bond Return		
Regulatory Period	LR	Pre-LR	All	LR	Pre-LR	All
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[Constr.\,Bond]$	-2.978***	-5.981***	-6.999***	-0.128***	-0.158***	-0.158***
	(0.450)	(1.087)	(1.103)	(0.034)	(0.023)	(0.027)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	1.731	-4.908	-3.710	-0.277	-0.306	-0.160
	(1.829)	(3.800)	(3.991)	(0.535)	(0.482)	(0.485)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	**3.874*****	-3.382*	-3.202	**-0.237*****	-0.021	-0.006
	(1.217)	(1.917)	(1.913)	**(0.081)**	(0.087)	(0.084)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[LR\,Period]$			4.330***			0.033
			(1.183)			(0.039)
$\mathbb{1}[Flow \in [0\%, 20\%)] \times \mathbb{1}[LR\,Period]$			2.461			-0.053
			(4.059)			(0.713)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Flow \in [0\%, 20\%)]$			**7.118*****			**-0.221***
			(2.312)			**(0.122)**
Observations	68,920	50,404	119,455	74,593	55,452	130,165
R-Squared	0.41	0.44	0.41	0.14	0.20	0.15
Issuer FE	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓
Bond and market controls	✓	✓	✓	✓	✓	✓