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

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Abstract

We show that after the introduction of leverage ratio constraints on bank-affiliated dealers, bond mutual funds have engaged in more liquidity provision in investment-grade corporate bonds and that the performance of funds with liquidity-supplying strategies has benefited. Not only have regulations transferred profits associated with liquidity provision in the corporate bond market to mutual funds, but the liquidity and returns of investment-grade corporate bonds have become more exposed to redemptions from the bond mutual fund industry, suggesting that the regulations may have made investment-grade corporate bonds more volatile. Accordingly, we observe that investment-grade corporate bonds that are more exposed to leverage ratio constraints experienced a 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

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1 Introduction

Because of the prudential regulations implemented in response to the global financial crisis, banks have become significantly more reluctant to intermediate markets for safe assets, which involve low-profitability trades (Duffie 2018). The same regulations have also significantly decreased the propensity of bank-affiliated dealers to provide liquidity in the corporate bond market (Bessembinder et al. 2018; Choi et al. 2023; Rapp and Waibel 2023). However, what remains unknown is how the behavior and performance of unregulated market participants have changed. Not only have the regulations changed trading opportunities for unregulated intermediaries, but how unregulated intermediaries have responded to the regulations may also affect the functioning of the corporate bond market. It is important to understand to what extent unregulated financial intermediaries are able to substitute bank-affiliated dealers in the provision of liquidity and whether the constraints they face, which affect their liquidity needs, may introduce new elements of fragility in 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 are affecting liquidity conditions could significantly impact mutual funds' strategies and performance. The sign of this effect, 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 liquidity provision by regulated financial institutions and possibly earn an alpha on their trades.

This paper shows that mutual funds that engage in liquidity provision indeed 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 subject to large redemptions from the bond mutual fund industry, suggesting that tighter regulations may have made liquidity conditions in the bond market more volatile.

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. 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, large bond inventories are 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 create regulatory pressure on dealers' investment-grade holdings and may, therefore, constrain their willingness to hold investment-grade bonds and to provide liquidity.

By design, the leverage ratio requirements become most binding at quarter-ends, which is when bank-affiliated dealers sharply contract their corporate bond inventories (Du et al. 2018; 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 time-varying proxy for mutual funds' strategies inspired by Anand et al. (2021). Specifically, we classify the extent to which a fund has a liquidity-demanding strategy based on the correlation of the fund's trades with dealers' inventory cycles. 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 sells like the rest of the market, asserting 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 and thus likely in need of liquidity supply. 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 whole sample period. Importantly, the quarter-end purchases of investment-grade bonds predominantly intermediated by dealers subject to the leverage ratio constraints subsequently outperform other purchases of LS mutual 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 more negatively affected by the leverage constraints. In addition, we show that the alpha of LS funds, after the introduction of the leverage constraints, is entirely realized in the first month of each quarter. This is consistent with our finding that LS funds are able to 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, those LS funds affiliated with dealers subject to the leverage ratio constraints benefit significantly more in terms of performance.

We also evaluate the aggregate implications of the changes in mutual funds' behavior for the bond market. We show that the extent to which mutual funds adopt liquidity-supplying strategies and engage in liquidity provision depends on their previous performance and flows. Poorly performing mutual funds are more likely to adopt liquidity-demanding strategies also because they need to sell to meet redemptions. As a result, in periods in which the average returns of LS mutual funds are lower, the probability that bond mutual funds engage in liquidity provision drops. For this reason, the liquidity and returns of investment-grade bonds have arguably become more exposed to large redemptions from the bond mutual fund industry after the adoption of the leverage ratio constraints.

We validate this interpretation of our empirical evidence by considering cross-sectional differences in bond liquidity and returns during the onset of the COVID-19 pandemic. We show that when this 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.

Overall, our results suggest that recent banking regulations have transferred profits associated with liquidity provision in the bond market to unregulated institutions. While mutual funds play an important role in the supply of liquidity, helping to manage dealers' regulatory pressures at quarter-ends, the fact that liquidity provision is now reliant on open-ended investment funds makes the corporate bond market more susceptible to investor redemptions.

We contribute to a growing 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; 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 effects 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 regulations may have affected unregulated market participants. A notable exception is O'Hara et al. (2022) who show that insurance companies provided liquidity during the March 2020 bond market meltdown, benefiting primarily the dealers with which they had strong trading relationships. Insurers and mutual funds differ significantly in their liabilities and hence their investment horizons and strategies (Cella et al. 2013; Chodorow-Reich et al. 2021; Coppola 2022; Huang et al. 2021). The nature of their liquidity provision and its effects on bond markets will also likely differ. Not only do we explore the extent to which unregulated market participants provide liquidity to dealers subject to regulatory constraints, but to the best of our knowledge, we are the first to consider mutual funds and the effects of leverage ratio constraints on their performance, bond liquidity, and bond returns.

Finally, we contribute to a 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 covered interest rate parity deviations (Du et al. 2018; Cenedese et al. 2021), temporary money market dislocations (d'Avernas and Vandeweyer 2022; Correa et al. 2022; He et al. 2022), the yield curve (Du et al. 2022), and changes in the repo market structure and bank risk-taking (Allahrakha et al. 2018; Choi et al. 2020). 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 their changed behavior may increase volatility in the corporate bond market during periods of turmoil.

2 Changes in Regulatory Environment

Banks, and their affiliated dealers, have always been subject to risk-weighted capital requirements, which are reported at quarter-ends. Because the capital that a regulated institution has to set aside depends on the risk of the assets, risk-weighted capital regulations increase the inventory costs of riskier bonds for banks and consequently may constrain bank-affiliated dealers' liquidity provision in these bonds, especially at quarter-ends.

Since the global financial crisis, a wide range of regulatory reforms has significantly increased banks' balance sheet costs for market making activities. As we explain below, the design of the newly introduced regulations allows us to identify how the constraints imposed on bank-affiliated dealers have affected bond mutual funds. Specifically, the implementation of Basel III in January 2015, and the consequent introduction of non-risk-weighted capital requirements, have increased the cost of balance sheet expansion for banks and bank-affiliated dealers. 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 their risk. Thus, what matters for the leverage ratio requirements is the balance sheet size, rather than its riskiness. For these reasons, the leverage ratio regulations have led intermediaries to shed 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 (Rapp and Waibel 2023).

The leverage ratio requirements were differently implemented across jurisdictions because of differences in the pre-existing regulations. US banks always had non-risk-weighted capital requirements, which seemed not to have much bite (Du et al. 2018), but the leverage ratio became more stringent in 2015 for systemically important financial institutions, with the introduction of the supplementary leverage ratio regulations. In addition, for US banks, the leverage ratio is computed as an average over the quarter. By contrast, for international banks, not only were the non-risk-weighted capital requirements newly introduced in January 2015, but they are computed on the basis of the leverage ratio at the end of each quarter. The implementation of the regulation changed in 2018 for UK banks, for which the leverage ratio started to be averaged over a quarter.

Following the introduction of the leverage ratio constraints, all bank-affiliated dealers subject to the constraints appear to contract their investment-grade bond inventories and the constraints have been shown to be particularly binding at quarter-ends both for non-US bank-affiliated dealers and US financial institutions that are declared to be of systemic importance (Rapp and Waibel 2023). For this reason, in computing securities' exposures to the leverage ratio regulations we will not distinguish between intermediaries for which the leverage ratio is computed at the end of the quarter or as an average during the quarter.

Overall, the dealers subject to the leverage ratio regulations constitute a significant part of the market and can therefore affect bond market conditions. Hence, the fact that the regulation becomes more stringent at quarter ends allows us to identify the effects, if any, of the leverage ratio constraints on mutual funds' strategies by exploiting the within-quarter timing of mutual funds' trades and portfolio performance together with cross-sectional variation in the extent to which recent market makers of a bond are affected by the leverage ratio constraints.

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. Our main 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 pandemics. 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 a variety of 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 80% of the fund reporting-period observations in our sample 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.

3.2 Classifying Funds' Strategies

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 the regulatory version of TRACE transactions data, we compute, on each trading day, the inventory change in a given bond for an individual dealer and then aggregate the inventory change across all dealers to obtain a measure of the change in the dealer sector's inventory in the bond.[1]

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

[1]Only principal trades (not agency trades) imply changes in dealers' inventories.

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 for 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.

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:

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

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 report their positions 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 the empirical analysis, we classify funds with a positive rolling-average *LS_score* 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 (58,048 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 the mean of about $2.52 billion and the median of only $0.54 billion. Institutional share classes represent 58% of the average fund's TNA. 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 -2.7% and 4.2%, 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.[2] LS funds tend to have more stable funding, as evidenced by a higher fraction of institutional share classes. This suggests that funds' ability to engage in LS strategies may be constrained by the characteristics of their liabilities (Giannetti and Kahraman 2018; Anand et al. 2021).

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 in terms of bond issue size, rating, age, or effective duration are very similar to those of other funds. Also, 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 16.32% per month, which is equivalent to almost 200% over a year, for funds that report their positions monthly. Table 1, Panel B shows that bond mutual funds trade a number of bonds in each reporting period, with each bond accounting for just about 0.04% of the average fund's total amount of trading. However, LS funds trade in a more concentrated manner, with each transaction representing a higher fraction

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

of the fund's total trading amount in each reporting period. To make sure that the different characteristics of LS and non-LS funds do not drive our findings, we include a host of fund characteristics as controls in our fund-level and fund-bond-level regressions.

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 and cancellations and reversals, as described by Dick-Nielsen and Rossi (2019), and further exclude i) bonds with less than 5 trades over the sample period; ii) bonds with a reported trade size that exceeds the bond's 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 a bond to regulatory constraints. Therefore, similar to Adrian et al. (2017), we construct a measure of past intermediation activity in a bond by bank-affiliated dealers that are subject to leverage constraints. We use the regulatory version of TRACE, which includes unmasked dealers' identities. In line with the literature, we define European and Japanese bank-affiliated dealers and U.S. bank-affiliated dealers that become 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 build up in bond j during the first twenty days of a month relative to bond j's issue size:

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

where d refers to a dealer 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.[3] 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, not their sales, generate balance sheet pressure under the leverage ratio rules. Each month, we sort bonds into quintiles based on their change in inventory by constrained dealers relative to the bond issue size (Constr. Dealers' Inventory $\text{Holdings}_{j,m}$). We define bonds in the top quintile as *constrained bonds* because constrained dealers are likely to have more inventories than desired and may not want to accumulate more to avoid expanding their balance sheets.

Table 1, Panel C reports descriptive statistics on the characteristics of the bonds in our sample. The first five columns highlight the full sample (767,819 bond-period observations). On average, the bond maturity is 9.5 years, the issue size is $916 million, and the bond age is 4.2 years. Approximately 60% of the bond-month observations are for investment-grade bonds, and the average credit rating is about BB+. Together, all taxable mutual funds own about 9.7% of the average bond issue in our sample.

The last two columns of Table 1, Panel C report the average characteristics separately for constrained and unconstrained bonds. Throughout our sample period, constrained dealers' shares of inventory holdings relative to the bond issue size are around 2.6% for constrained bonds but just 0.36% 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 for 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 tend to be larger in issue size, younger, and have slightly higher 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 in bonds that involve less risk and 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

[3] Due to the 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).

affect the interpretation of our findings, we show that our results are robust when we match constrained bonds to similar but unconstrained counterparts. 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 A2 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 (without replacement) an unconstrained bond with the smallest absolute distance in terms of the estimated propensity score. Table A1 provides the covariate balance and shows that the characteristics of constrained and unconstrained bonds are not statistically different in this matched sample.

4 Leverage Constraints and Funds' Trading

We start by exploring how mutual funds' trading changed after the introduction of the leverage ratio regulations. To identify the effects of the regulations on mutual funds' strategies, we exploit cross-sectional differences between bonds, as well as within-quarter variation in the constraints faced by bank-affiliated dealers. Specifically, we expect the effects of the leverage ratio constraints to be detectable only for investment-grade bonds because bank-affiliated dealers' liquidity provision in high-yield bonds was already constrained by Basel II regulations. In addition, investment-grade bonds for which dealers affected by the regulations have provided liquidity in the recent past and have therefore accumulated inventories should be more affected. Finally, any effects should be particularly strong at quarter-ends, when the leverage ratio constraints become more binding.

Our empirical tests exploit all these sources of variation to identify the effects of the regulations on mutual funds' strategies. Specifically, we estimate the following fund, bond, month level regression:

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

The dependent variable is defined as

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

where $par\_change_{i,j,t}$ 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 $t-1$.

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 (QE) and bond j has been intermediated by dealers subject to the leverage ratio constraint, as captured by the dummy *Constr. Bond*. We estimate the above equation, distinguishing between the periods before and after the introduction of the leverage ratio constraints and also between LS and non-LS funds to account for the fact that mutual funds' strategies change little over time, and non-LS funds may be unable to change their behavior. We control for bond and fund characteristics, $M_{j,t}$ and $M_{i,t}$, respectively, and also include 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.

Table 2 reports the estimates. Panel A considers the period before the introduction of the leverage ratio constraints. We observe no change in mutual fund trading at quarter-ends, irrespective of whether we consider LS or non-LS funds, or investment-grade or high-yield bonds. In Panel B, we focus on the period after the introduction of the leverage ratio requirements. While liquidity-demanding funds do not appear to change their trading behavior, at quarter-ends, LS funds purchase more investment-grade bonds, which have been intermediated by dealers subject to the leverage ratio constraints. The effect is not only statistically, but also economically significant as the increased purchases at quarter-ends for constrained bonds in column 5 are equivalent to about 25% of the average change in a fund's position size. Interestingly, we do not find a similar effect for high-yield bonds, which we expect to have been affected by constraints on regulated dealers already during the pre-leverage ratio period. While both LS and non-LS funds purchase constrained high-yield bonds already before the introduction of the leverage ratio regulations, their purchases do not appear to increase at quarter ends. High-yield bonds are riskier and have more volatile returns than investment-grade bonds. These factors are known to hamper liquidity provision by open-end mutual funds (Giannetti and Kahraman 2018), especially because the expected return from liquidity provision is relatively low.

Table 3 confirms the above results by estimating a triple-difference specification for the pre- and post-leverage-ratio periods, respectively. It appears that LS funds purchase more constrained investment-grade bonds at quarter-ends, compared to non-LS funds, only after the leverage ratio period. In terms of economic magnitude, the increase in positions by LS funds in the constrained bonds at quarter-ends, based on the estimates in column 5, is 25% higher than the average increase in position.[4] Importantly, the coefficient on the relevant triple interaction term is not statistically different from zero during the pre-leverage ratio period and the parameter estimate is 30 times smaller than during the leverage ratio period. The estimates appear qualitatively and quantitatively invariant in Table A5, where we reestimate Table 3 considering only securities in our matched sample.

Overall, the changes in trading behavior of LS funds appear to be economically relevant. We thus ask whether the quarter-end trades of LS funds in constrained bonds are particularly profitable. Table 4 presents the average next-month portfolio returns of all bonds purchased by our sample funds during quarter-end versus non-quarter-end months, distinguishing between pre- and post-leverage ratio periods, investment-grade and high-yield bonds, and constrained and unconstrained bonds. It appears that funds' purchases of constrained investment-grade bonds during the last month of a quarter outperform other purchases after the introduction of the leverage constraints (Panel A). This effect is economically meaningful as the outperformance of constrained bond purchases over other purchases is 0.23% per month (or 2.76% on an annualized basis) higher at quarter ends than non-quarter ends. We find no statistically significant outperformance for quarter-end purchases of constrained investment-grade bonds before the introduction of the leverage ratio constraints.

In Panel B, we consider the monthly returns of the high-yield bonds purchased by mutual funds. We find that quarter-end purchases of constrained high-yield bonds outperform other purchases also during the pre-leverage ratio period. This is consistent with risk-weighted capital ratio requirements constraining bank-affiliated dealers' liquidity provision over the whole sample period. Unsurprisingly, the returns from liquidity provision in the more illiquid high-yield bonds are higher and, consistent with our interpretation of the empirical evidence, do not increase after the introduction of the leverage ratio constraints.

[4] Tables A3 and A4 in the Appendix confirm that we fully retain the documented effect when we focus our analysis only on quarters 1 to 3. This addresses the concern that our estimates are distorted or driven by the additional capital requirements for globally systemically important banks (G-SIBs) that are calculated based on year-end balance sheet values (Behn et al. 2022).

5 Leverage Constraints and Funds' Performance

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

To evaluate fund performance, we start by computing each fund's monthly alpha, using the factor model of Chen and Qin (2017). We estimate the fund's benchmark returns over a rolling window of 24 months prior to 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 the fund's trading style including 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, institutional share class fraction, average maximum rear load, % cash, % government bonds, % corporate bonds, average coupon rate, average credit rating, effective duration, average bond issue size, and average bond age).

Specifically, we estimate the following regression at the fund-month level:

$$\begin{aligned} Fund\,Alpha_{i,t} = &\ \beta_0 + \beta_1\,\mathbb{1}[LR] + \beta_2\,\mathbb{1}[LS\ Fund] + \beta_3\,\mathbb{1}[LR] \times \mathbb{1}[LS\ Fund] \\ &+ \theta'\,\mathbf{M_{i,t}} + \eta_c \times \lambda_t + \varepsilon_{i,t}. \end{aligned}$$

The dependent variable, $Fund\,Alpha_{i,t}$, refers to the monthly fund alpha. $\mathbb{1}[LR]$ is an indicator variable that is one during the leverage ratio period, that is, from 2015 onwards. $\mathbb{1}[LS\ Fund]$ is an indicator that is one if the fund is identified as having a liquidity-supplying trading style. $\mathbf{M_{i,t}}$ refers to a vector of time-varying fund controls, η_c denotes fund-category fixed effects, and λ_t denotes month fixed effects. Our coefficient of interest is β_3, 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 5 reports the results. In column 1, we consider all bond funds without distinguishing between investment-grade and high-yield focused funds. We do not find any statistically significant difference in performance between LS and non-LS funds either before or after the leverage ratio period. In columns 2 and 3, we investigate the sub-sample of funds that focus on investment-grade bonds and find that LS funds outperform non-LS funds only in the leverage ratio period. We find no evidence that investment-grade LS funds outperform other funds in the earlier periods or that high-yield LS funds' performance, relative to other high-yield funds, changes in the leverage ratio period (columns 4 and 5).

Importantly, after the introduction of the leverage ratio constraint, the outperformance of investment-grade LS funds, relative to non-LS funds, appears not only statistically but also economically significant at approximately 2.2 basis points per month or 0.26% per annum (column 2). Our findings are stronger when we exclude the taper tantrum (column 3), a period of turmoil before the introduction of the leverage ratio constraint, during which liquidity provision by LS funds may have been particularly profitable.

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. Accumulation of inventories in high-yield bonds was costly for bank-affiliated dealers even before the introduction of leverage constraints because of the presence of risk-weighted capital regulation. The introduction of the leverage ratio rules disproportionately increases 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 size, but not on the risk of the bank's assets. It is therefore unsurprising that the performance of investment-grade funds benefit to a larger extent from the leverage ratio rules.

To provide more compelling evidence that the newly introduced regulations affect mutual funds' performance, we consider during which months of a quarter an LS fund obtains a 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 constraint. If the outperformance of LS funds derives from the fact that the leverage constraints increase the profitability of supplying liquidity when bank-affiliated dealers are constrained, then 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 6. Following the introduction of the leverage ratio constraints, LS investment-grade funds significantly outperform other investment-grade 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 months and also not for the subset of high yield funds.

6 Which Funds Take Advantage of Liquidity Provision?

Our results so far demonstrate that the leverage ratio requirements imposed by Basel III have created profitable trading opportunities for bond mutual funds in investment-grade bonds. Constrained bank dealers have been shown to sell their bond holdings primarily to investors and nonbank financial intermediaries in their networks (Rapp and Waibel 2023). Within their network, banks could further favor their affiliated funds to primarily profit from liquidity provision to their affiliated dealers. However, since engaging in liquidity provision for investment-grade bonds is profitable and involves limited risk, all mutual fund managers, irrespective of their affiliation with a dealer, should have incentives to compete for these trades. Exclusively relying on affiliated funds may also not be feasible and further hampered by the fact that bank-affiliated dealers need to reduce their inventories in many bond positions at quarter-ends. It is thus an empirical question whether all funds engage in liquidity provision to benefit from the opportunities created by the regulation or exclusively bank-affiliated mutual funds do so.

Table 7 considers to what extent affiliated mutual funds are more likely to engage in liquidity provision. To identify funds affiliated with a given dealer, we match the fund management companies and fund advisors from CRSP to our set of constrained banks by name. We then define a fund to be affiliated with a given (constrained) dealer if either the fund management company or the fund advisor is affiliated with the constrained bank dealer. We focus on the leverage ratio period. The estimates confirm our earlier results that LS funds provide liquidity in constrained bonds, particularly investment-grade bonds, at quarter-ends. The statistically insignificant coefficient estimates on the triple interaction $\mathbb{1}[QE] \times \mathbb{1}[Constr. Bond] \times \mathbb{1}[Bank - aff.]$ in all columns indicate 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 investment-grade bonds.

It comes at 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 purchasing dealers' inventories involved large 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 primary market allocations in the future, had incentives to engage in liquidity supplying trades. By contrast, mutual funds' liquidity provision in normal 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 to constrained banks, it appears plausible that constrained bank dealers favor their affiliated funds by directing more profitable trades to them. We test this hypothesis by exploring whether bank-affiliated funds perform better from engaging in liquidity provision. This is precisely what we observe in Table 8. While all investment-grade bond funds generate an alpha from LS strategies after the introduction of the leverage ratio regulations, the alpha of investment-grade LS funds that are bank-affiliated is over three times larger than that of other LS funds, suggesting that constrained bank dealers direct their best trades to their affiliated funds.

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. Our conjecture is that funds should be more likely to adopt LS strategies if they expect such strategies 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.

We test these conjectures by relating the probability that a fund has a positive LS score during a month to a rolling average of the performance of all LS funds over the previous 12 months. We also consider whether the flows (rolling averages over the past 12 months) of an individual fund affect its propensity to provide liquidity, controlling for the fund's style and other characteristics by including fund Morningstar category dummies and other fund-level controls, including both time-varying fund and portfolio characteristics.[5]

The estimates in column 1 of Table 9 for the full sample show that funds with higher recent flows are more likely to have a positive LS score. Importantly, the probability that a fund has a positive LS score is positively related to the previous performance of LS strategies. In the rest of the table, we consider separately the periods before and after the introduction of the leverage ratio constraints and distinguish between funds focused on investment-grade and high-yield bonds. While flows affect a fund's liquidity provision throughout the sample and both for high-yield and investment-grade bond funds, the fund's recent performance only affects investment-grade funds' LS strategies in the leverage ratio period, suggesting that the industry adjusts to the new regulations.

In terms of economic magnitude, an increase of around one standard deviation in the past 12-month average alpha of LS strategies raises the probability of a fund pursuing an LS strategy by about 0.05, which is highly significant from an economic point of view, given the average fraction of LS funds being just 0.24-0.27. Importantly, 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.

The finding that high-yield bond funds are not more likely to engage in LS strategies when LS funds' prior performance is higher is consistent with our earlier finding that high-yield bond funds do not exploit the trading opportunities associated with liquidity provision in high-yield bonds and supports our argument that open-ended organizations are unlikely to find it optimal to engage in the liquidity provision for assets with volatile returns. Incentives appear to be different for the safer investment-grade bonds. Unregulated financial institutions readily jump in to provide liquidity after the new regulations limiting liquidity provi-

[5]We use as our measure of LS strategy, the dependent variable of the regressions, a dummy that equals one if the fund's LS_score is positive at time t to be able to detect short-term changes in strategies.

sion by the affected bank-affiliated dealers increased the performance of liquidity-supplying strategies.

While the finding that mutual funds liquidity provisions in investment-grade bonds responds to the profitability of trading opportunities suggests that the regulations should not hamper 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. These findings raise concerns that liquidity provision in the bond market is dependent on fund flows and performance. Furthermore, the fact that bond mutual funds do not provide liquidity in high-yield bonds suggests that in periods of high risk, when LS funds perceive the returns from their strategies to be too volatile, liquidity in investment-grade bonds may suddenly drop. Outflows during episodes of turmoil, as experienced in March 2020 at the onset of the COVID-19 pandemics (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 shift in liquidity provision from bank-affiliated dealers to open-ended bond mutual funds has had systematic effects on 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 is large enough to potentially affect bond liquidity and returns, we identify liquidity-supplying funds' monthly net liquidity supply in investment-grade corporate bonds during a positive inventory cycle and relate it to the dealer sector's average inventories in the same bonds.

Table 10 shows how the extent as well as the pattern of mutual funds' liquidity provision has changed relative to the pre-leverage ratio period. We start by focusing on bonds that LS funds are trading in a given month (Panel A), but the overall message is unchanged if we consider all bonds traded by mutual funds in a given month (Panel B). After the introduction of the leverage ratio regulation, liquidity-supplying funds' liquidity provision is concentrated in the last month of the quarter and involves only constrained bonds. In 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, 16% of dealers' mean inventories in constrained bonds at quarter ends, funding shocks affecting bond mutual funds can potentially have significant effects on the corporate bond market. In what follows, we evaluate to what extent this is the case.

8.2 Liquidity

We have so far shown that mutual funds provide a substantial amount of liquidity in the corporate bond market, at quarter-ends, when bank-affiliated dealers' constraints are particularly binding. However, 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 are intermediated by regulated dealers may have become more dependent on mutual funds' flows, especially at quarter ends.

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

$$
\begin{aligned}
Illiquidity_{j,t} = {} & \beta_0 + \beta_1\, \mathbb{1}[QE] + \beta_2\, \mathbb{1}[Flow \in [0\%, 20\%]] + \beta_3\, \mathbb{1}[QE] \times \mathbb{1}[Flow \in [0\%, 20\%]] \\
& + \theta'\, \mathbf{M_{j,t}} + \eta_s + \lambda_q + \varepsilon_{j,t}.
\end{aligned}
$$

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 market illiquidity: effective bid-ask spread, imputed round-trip cost, and the interquartile range measure. We then extract the first principal component of the three individual measures and use it as our main illiquidity proxy.[6] Among the independent variables, $\mathbb{1}[QE]$ is an indicator that takes the value of one for quarter-end months and zero otherwise; $\mathbb{1}[Flow \in [0\%, 20\%]]$ is an indicator that equals one if the aggregate fund flows during month t are in the bottom 20 percent of the sample and zero otherwise; $\mathbf{M_{j,t}}$ refers to the standard set of bond-month controls; η_s

[6] During our sample period the first principal component of the three illiquidity proxies explains around 68% of the variation. It has a mean of -7.62, and a standard deviation of 76.22.

denotes issuer fixed effects, and λ_q denotes quarter fixed effects.

Our objective is to test whether bond mutual funds' funding constraints affect liquidity conditions for investment-grade bonds at quarter-ends, after the introduction of the leverage ratio requirements. Like in our previous tests, we expect the effect to be driven by investment-grade bonds that during the previous months were intermediated predominantly by bank-affiliated dealers and that therefore we define as constrained. Throughout the analysis, in addition to usual bond characteristics, we control for aggregate flows to bond mutual funds, because we expect their demand for corporate bonds to have always been related to bond liquidity conditions.

Table 11 reports the results. It is evident that in periods in which the net flows to the bond mutual fund industry are in the bottom quintile, constrained bonds have become more illiquid in quarter-end months (columns 5-8). There are no effects of low mutual funds flows, beyond the average effects of flows for which we control, on bond illiquidity among unconstrained bonds (columns 1-4), in the pre-leverage ratio period (columns 1,2, 5, and 6), or outside of quarter-ends, when bank-affiliated dealers' leverage constraints are less binding. Also, constrained high-yield bonds have experienced drops in liquidity at quarter-ends already in the pre-leverage-ratio period. This is again unsurprising because bank-affiliated dealers' inventories of high-yield bonds were subject to risk-based capital requirements that, as we noted before, also become binding at quarter-ends.

Not only do the statistically significant effects support our interpretation of the empirical evidence, but the effects of the regulations on bond liquidity are also economically significant. Specifically, during the leverage ratio period, but not before, illiquidity increases by about 6.18, or around 8% of its standard deviation, more for constrained investment-grade bonds at quarter ends, when mutual funds experience significant redemptions, as captured by the indicator for bond mutual funds' flows in the bottom quintile. Overall, the estimates are qualitatively and quantitatively unchanged in the matched sample (Table A6), indicating that the leverage ratio regulations have increased the exposure of constrained bonds to liquidity risk arising from mutual fund redemptions.

8.3 Returns

We have so far shown that after the introduction of the leverage ratio requirements, the liquidity of investment-grade corporate bonds has become more exposed to redemptions from the bond mutual fund industry. This liquidity risk could in turn affect bond returns. In this section, we adapt our methodology to test whether the leverage constraints also change the determinants of bond returns.

As is common in the literature, we compute monthly returns for bond j during 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 transaction price[7], $AI_{j,t}$ denotes the accrued interest, and $C_{j,t}$ is the coupon payment. Lastly, we compute the monthly excess return, $R_{j,t}$, as the difference between $r_{j,t}$ and the risk-free rate as proxied by the one-month Treasury bill rate.

In our regression model, we relate bond returns to the relevant (credit-rating-matched) index and allow the exposure to vary with bond maturity to capture duration effects. Moreover, in addition to usual bond characteristics, we control for aggregate flows to bond mutual funds. We then include our variables of interest capturing expected and realized 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 the uncertain funding conditions of bond mutual funds and provide a risk premium. We also test whether these bonds indeed underperform when mutual funds' liquidity provision is constrained because their flows are in the bottom quintile. As before, we control for time-varying bond characteristics, and include issuer and quarter fixed effects.

Table 12 reports the results. It appears that investment-grade bonds intermediated by bank-affiliated dealers at $t-1$ subsequently experience higher risk-adjusted returns, but only

[7] We compute monthly bond prices, $P_{j,t}$, by applying the following steps. First, using TRACE transaction data, we compute the daily bond price as the volume-weighted average of all intraday transaction prices. Second, we compute monthly returns using two definitions: A return from the end of month $t-1$ to the end of month t, and from the beginning of month t to the end of month t. We denote the end (beginning) of a month as the last (first) ten trading days within a month. If there are multiple transactions within the last (first) ten trading days we select the last (first) transaction in the ten day window. We then match the accrued interest to the date on which the price is taken for the return computation. Finally, if we can compute a monthly return under both definitions, we use the return from the end of month $t-1$ to the end of month t.

after the introduction of the leverage constraints (the coefficient on the constrained dummy is positive and statistically significant in column 3, but not in column 1). This supports our conjecture that being intermediated by dealers that retract at the end of the quarter involves a risk. The effect is not only statistically but also economically significant. In the leverage ratio constraint period, the estimate in column 3 indicates that constrained investment-grade bonds offer, on average, 7.6 basis points (about 0.91% annualized) higher returns per month than other investment-grade bonds. Importantly, the higher return appears to reflect compensation for liquidity risk. When mutual funds indeed experience significant redemptions, as captured by bond mutual funds' flows in the bottom quintile, constrained investment-grade bonds experience significant losses, losing about 24.6 basis points more than other investment-grade bonds. Our results are qualitatively and quantitatively unchanged in the matched sample (Table A7).

Interestingly, high-yield bonds intermediated by bank-affiliated bond funds provide a risk premium (about 9.4-13.0 basis points higher returns, compared to other high-yield bonds) during the whole sample period, consistent with our earlier findings. We do not find however that they experience lower returns in periods in which the aggregate flows to the bond mutual fund industry are in the bottom quintile, which is consistent with our earlier findings that bond mutual funds do not provide liquidity in high-yield bonds.

9 Leverage Constraints and the COVID-19 Shock

Our analysis over the years 2010-2019—a period without major global financial turmoil—has highlighted 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 introduction of leverage ratio constraints can help explain why liquidity conditions and consequently returns sharply deteriorated for corporate bonds at the onset of the COVID-19 pandemic, when especially investment-bonds experienced pronounced price dislocations (Haddad et al. 2021; Kargar et al. 2021; O'Hara and Zhou 2021).[8]

In the first three weeks of March 2020, before the Federal Reserve's intervention, bond mu-

[8] We focus on the period before the Federal Reserve Board's intervention in the corporate bond market through the Secondary Market Corporate Credit Facility (SMCCF).

tual 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 large price dislocations experienced by investment-grade bonds relative to high-yield bonds (Ma et al. 2022), we show that investment-grade corporate bonds intermediated by dealers subject to leverage ratio constraints experienced larger price dislocations than other investment-grade bonds, indicating that leverage constraints contributed to amplify the shock.

To begin our analysis, we examine whether illiquidity increased more for bonds that we defined as constrained. To avoid an overlap with inventory changes due to the bond selloff in early March, we lag our bond constraint measure, *Constr. Dealers' Inventory Holdings*$_{j,m-1}$. That is, we consider as constrained bonds 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 bonds' illiquidity where, for each bond, we compute the difference between the average illiquidity in February and the average illiquidity during the first 22 days of March. Over this period, the gravity of the COVID-19 pandemic became apparent, disrupting financial markets globally and ultimately leading to the Federal Reserve intervening to calm the U.S. corporate bond market and stabilize mutual fund flows on March 23.

Table 13 presents the estimates of the cross-sectional illiquidity regression. We present the estimates separately for the whole sample, investment-grade bonds, and high-yield bonds in columns 1, 2, and 3, respectively. We find that illiquidity increases more in constrained bonds, and that the effect is entirely driven by investment-grade bonds. The estimated effect is not only statistically significant, but also economically large. Whether a bond was affected by the leverage constraints changes illiquidity by about 11% of the standard deviation of the illiquidity changes from February to March 2020 in the subsample of investment-grade bonds. These results are consistent with our earlier findings, showing that mutual funds provide liquidity only in investment-grade bonds. It is thus unsurprising that the liquidity conditions of investment-grade bonds, in which bond mutual funds' liquidity provision would have been more critical, quickly deteriorated when unprecedented outflows prevented mutual funds from buying.

Table 14 reports the results from panel regressions of our bond illiquidity measure and bond returns. Our sample includes monthly observations for February 2020 and the first 22 days of March 2020. Our regressions include bond fixed effects to control for bond characteristics. In column 2, we find a statistically significant coefficient on the interaction term between the indicator variable capturing March 2020 and the constrained bond indicator. This finding confirms that illiquidity increased more for investment-grade bonds affected by the leverage ratio constraints. While all corporate bonds became more illiquid in March 2020, illiquidity increased by nearly 20% more for investment-grade bonds intermediated by dealers subject to the leverage ratio constraints. Importantly, columns 4 to 6 further show that all corporate bonds experienced negative returns, but the returns of constrained investment-grade bonds were about 50% lower than those of other investment-grade bonds. For high-yield bonds, in which bond mutual funds provide dealers with little liquidity supply, the leverage ratio constraints play a much smaller role in explaining cross-sectional differences in returns. Overall, this evidence confirms that the leverage ratio constraints can contribute to amplifying the effects of negative shocks in the corporate bond markets.

10 Conclusions

We provide the first evidence that the leverage ratio constraints introduced with Basel III have spillover effects on unregulated financial institutions. Specifically, we show that mutual funds provide liquidity in the corporate bond market when the leverage ratio constraints on bank-affiliated dealers are most binding and that their performance has benefited thanks to the regulation.

However, mutual funds' liquidity provision appears to depend on performance and flows and drastically decreases when the bond mutual fund industry experiences significant redemptions. As a consequence, liquidity in the corporate bond market has become dependent on bond mutual funds' funding conditions. Not only does corporate bond liquidity significantly deteriorate at quarter ends if there are significant redemptions in the bond mutual fund industry, but also bonds that are primarily intermediated by bank-affiliated dealers transact at a discount, and their valuations significantly deteriorate when the bond mutual fund industry experiences large outflows.

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11 Tables

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, presented as a fraction of TNA at the beginning of the month.
Government bonds as % of portfolio	Holdings of (U.S. and foreign) government bonds, as a percentage of TNA, as of the previous report date.

Variable Definitions and Data Sources [continued]

Variable	Definition
Institutional share class fraction	Fraction of institutional share classes in the fund's 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.

Variable Definitions and Data Sources [continued]

Variable	Description
Portfolio avg. credit rating	Value-weighted average credit rating, based on the credit ratings from Moody's, S&P, and Fitch 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 effective duration	Average effective 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 across all share classes of return in the current month.
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.

Variable Definitions and Data Sources [continued]

Variable	Description
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 previous period ($t-1$) total net assets (TNA). All position changes are calculated at prices as of the previous report date. Values are expressed in basis points.
Bond-level variables	
Frequency: bond-month	
Source: Mergent FISD, Morningstar and Regulatory TRACE.	
Bond illiquidity	First principal component of three standard metrics of corporate bond market 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 price 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.

Variable Definitions and Data Sources [continued]

Variable	Description
-*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 that the bond have at least three trades 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.

Variable Definitions and Data Sources [continued]

Variable	Description
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.
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.

Variable Definitions and Data Sources [continued]

Variable	Description
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. Following Bai et al. (2019), 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.
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.

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) that are 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.

Panel A: Fund-Level Variables

	Main Sample (58,048 Fund-Periods)					Mean by LS-Fund Type (15,920 / 42,128 Fund-Periods)	
Variable	Mean	Std	10%	50%	90%	LS Funds	Non-LS Funds
Total net assets ($ Mil.)	2517.84	9697.25	42.20	542.90	5163.54	3260.30	2237.89
Portfolio avg. bond issue size	1064	320	710	1016	1467	1055	1068
Portfolio avg. bond age (year)	3.83	1.13	2.60	3.65	5.26	3.98	3.77
Portfolio avg. credit rating (1 = AAA)	10.12	4.26	5.00	9.00	16.00	9.78	10.27
Portfolio effective duration (year)	5.56	6.45	2.59	4.90	8.94	5.25	5.67
Portfolio avg. coupon rate	5.41	2.63	3.39	5.19	7.60	5.16	5.51
Corporate bonds as % of portfolio	55.52	39.41	23.56	48.86	92.44	55.32	55.59
Government bonds as % of portfolio	15.23	21.44	0.00	8.69	42.10	15.57	15.11
Cash as % of portfolio	8.26	19.75	0.44	5.74	20.01	9.18	7.92
Flow (%)	0.7	4.26	-2.66	0.28	4.19	1.21	0.50
Alpha (%)	-0.04	0.55	-0.53	-0.02	0.44	-0.03	-0.05
Fund age	2.43	0.86	1.15	2.65	3.38	2.23	2.51
Broker affiliation	0.09	0.29	0.00	0.00	0.00	0.09	0.09
Institutional share class fraction	0.58	0.38	0.00	0.66	1.00	0.66	0.56
Turnover (%)	16.32	17.12	3.45	11.27	33.33	16.99	16.07
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

Variable	Main Sample (13,388,072 Fund-Bond-Periods)					Mean by LS-Fund Type (3,969,474 LS Bond-Periods 9,418,598 Non-LS Bond-Periods)	
	Mean	Std	10%	50%	90%	LS Funds	Non-LS Funds
Fund pos. change / TNA_{t-1} (bp)	0.37	7.71	0.00	0.00	0.25	0.50	0.32
Fund pos. change / Trd. vol (%)	0.04	1.01	0.00	0.00	0.07	0.05	0.03
Fund trd. volume ($ mn)	100.67	329.31	1.77	19.76	204.85	92.14	103.89

Panel C: Bond-Level Variables

Variable	Main Sample (767,819 Bond-Periods)					Mean by Bond Constr. Type (156,888 Constr. Bond-Periods 610,931 Unconstr. Bond-Periods)	
	Mean	Std	10%	50%	90%	Constrained	Unconstrained
Bond rating (1 = AAA)	10.97	5.32	6.00	10.00	17.00	9.95	11.40
Bond age (year)	4.20	3.30	1.36	3.27	8.13	4.53	4.06
Bond maturity (year)	9.49	9.04	3.04	7.26	24.31	9.47	9.50
Bond issue size ($ mn)	915.63	714.87	299.40	700.00	1948.46	902.79	921.34
Investment grade	0.60	0.49	0.00	1.00	1.00	0.71	0.55
Upgrade	0.01	0.10	0.00	0.00	0.00	0.01	0.01
Downgrade	0.01	0.08	0.00	0.00	0.00	0.01	0.01
Mutual fund ownership	0.11	0.08	0.02	0.09	0.21	0.12	0.10
Bond Illiquidity							
Interquartile range (bp)	44.28	50.88	6.25	26.91	105.00	42.65	46.36
Imputed roundtrip cost (bp)	17.85	29.97	0.00	7.53	44.66	13.77	16.63
Effective bid-ask spread (bp)	54.67	76.84	3.99	28.28	136.45	49.69	57.93
First principal component	-10.73	80.09	-69.54	-38.88	82.71		
Bond return (%)	-0.60	2.40	-2.87	-0.54	1.87	-0.51	-0.61
Bond constraint (%)							
Quintiles 1-4	0.36	0.47	0.01	0.21	0.87	-	-
Quintile 5	2.60	2.64	1.06	1.93	4.67	-	-

Table 2
Fund Liquidity Provisioning in Constrained and Unconstrained Bonds

This table displays estimates for the regression:

$$Fund\,Position\,Change_{i,j,t} = \beta_0 + \beta_1\,\mathbb{1}[QE] + \beta_2\,\mathbb{1}[Constr.\ Bond] + \beta_3\,\mathbb{1}[QE] \times \mathbb{1}[Constr.\ Bond] + \theta_1'\,\mathbf{M_{j,t}} + \theta_2'\,\mathbf{M_{i,t}} + \eta_j \times \lambda_y + \varepsilon_{i,j,t}.$$

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position 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. $\mathbb{1}[Constr.\,Bond]$ 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, institutional share class fraction, 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, an indicator that is one if the bond is investment-grade and zero otherwise, 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 $t-1$. $\eta_j \times \lambda_y$ represents bond-year fixed effects. Panel A focuses on the pre-leverage ratio period (01/2010-12/2014), and Panel B focuses on the leverage ratio period (01/2015-12/2019). Columns 1-3 consider the subsample of non-LS funds while columns 4-6 consider the subsample of LS funds. Standard errors, double-clustered at the fund family and quarter level, are in parentheses. , *, and *** indicate statistical significance at the 10%, 5% and 1% levels.
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Table 2 - continued

Panel A: Pre-Leverage Ratio Period

Fund Type	Non-LS Funds			LS Funds		
Bond Type	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.061	0.072	0.041	0.036	-0.047	0.220
	(0.052)	(0.059)	(0.064)	(0.068)	(0.057)	(0.142)
$\mathbb{1}[Constr.\ Bond]$	0.157***	0.080	0.240***	0.274***	0.207**	0.428***
	(0.047)	(0.047)	(0.067)	(0.080)	(0.079)	(0.096)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\ Bond]$	-0.009	0.023	-0.046	0.026	0.018	-0.021
	(0.077)	(0.095)	(0.101)	(0.078)	(0.080)	(0.117)
R-Squared	0.11	0.11	0.13	0.16	0.15	0.17
Observations	2,391,166	1,308,657	1,082,392	714,569	472,683	241,671

Panel B: Leverage Ratio Period

Fund Type	Non-LS Funds			LS Funds		
Bond Type	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.036	0.046	0.026	0.068*	0.045	0.146
	(0.028)	(0.030)	(0.040)	(0.039)	(0.029)	(0.097)
$\mathbb{1}[Constr.Bond]$	0.072*	0.065*	0.076	0.071*	0.044*	0.157**
	(0.036)	(0.032)	(0.047)	(0.038)	(0.025)	(0.062)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.Bond]$	0.018	-0.012	0.051	**0.105****	**0.095****	0.107
	(0.047)	(0.050)	(0.053)	**(0.050)**	**(0.041)**	(0.069)
R-Squared	0.08	0.08	0.09	0.10	0.09	0.11
Observations	3,277,419	1,818,402	1,458,881	1,792,554	1,365,942	426,452
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table 3
Quarter-End Liquidity Provisioning Before and After Basel III

This table displays estimates for the regression:

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

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in bond j position of fund i at time 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. $\mathbb{1}[LS\,Fund]$ 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 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, 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), and time-varying fund characteristic (age, size, family size, institutional share class fraction, and average maximum rear load). $M_{j,t}$ represents bond controls and includes the bond age, bond maturity, downgrade and upgrade indicators, an indicator that is one if the bond is investment grade and zero otherwise, and the 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 $t-1$. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample period is 01/2010 - 12/2019. Columns 1-3 restrict the sample to the pre-leverage ratio period (01/2010-12/2014). Columns 4-6 restrict the sample to the leverage ratio period (01/2015-12/2019). Standard errors, double-clustered at the fund family and quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Pre-Leverage Ratio			Leverage Ratio		
Bond Rating	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.072	0.085	0.047	0.029	0.034	0.029
	(0.055)	(0.062)	(0.064)	(0.028)	(0.029)	(0.041)
$\mathbb{1}[LS\,Fund]$	0.106*	0.076	0.101	0.063**	0.037	0.116**
	(0.056)	(0.063)	(0.076)	(0.029)	(0.025)	(0.050)
$\mathbb{1}[Constr.\,Bond]$	0.149***	0.073	0.236***	0.052	0.049	0.067
	(0.044)	(0.045)	(0.066)	(0.036)	(0.036)	(0.046)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[QE]$	-0.022	-0.122*	0.183	0.063	0.036	0.118
	(0.081)	(0.069)	(0.137)	(0.040)	(0.026)	(0.102)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[QE]$	-0.010	0.021	-0.043	0.022	-0.004	0.057
	(0.077)	(0.092)	(0.099)	(0.046)	(0.048)	(0.052)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Constr.\,Bond]$	0.149	0.147	0.209***	0.056	0.018	0.120**
	(0.095)	(0.127)	(0.071)	(0.068)	(0.077)	(0.045)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Constr.\,Bond] \times \mathbb{1}[QE]$	0.041	0.003	0.009	0.083*	**0.092****	0.039
	(0.051)	(0.058)	(0.089)	(0.046)	**(0.038)**	(0.059)
R-Squared	0.11	0.10	0.13	0.08	0.08	0.09
Observations	3,108,437	1,783,226	1,325,127	5,071,782	3,185,688	1,886,009
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table 4
Average Bond Returns

This table reports average monthly returns of constrained and unconstrained bond purchases by mutual funds. Every month from January 2010 to December 2019, each fund's portfolio is split into a constrained and an unconstrained portion. The fund's position holdings are restricted only to bond positions that are purchased in month t. All bond returns are as of month $t+1$. Average portfolio returns are computed for each fund every 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. Panel A considers investment-grade bonds, and Panel B considers high-yield bonds. We report in brackets the standard deviations of the funds' portfolio returns, and for the columns with Δ in the heading, the absolute values of t-statistics for the difference in average return between constrained and unconstrained bond purchases in quarter-end months minus the difference in average return between constrained and unconstrained bond purchases in non-quarter-end months.

Panel A: Excess Returns - IG Bonds

	Pre-Leverage Ratio			Leverage Ratio		
Porfolio	Non-Quarter-End Month	Quarter-End Month	Δ	Non-Quarter-End Month	Quarter-End Month	Δ
Constrained	-0.16 (0.99)	0.91 (1.25)		-1.30 (1.04)	-0.23 (1.80)	
Unconstrained	-0.10 (0.68)	0.85 (1.00)		-1.15 (0.92)	-0.31 (1.56)	
Constrained - Unconstrained	**-0.06**	**0.06**	**0.12** **(0.86)**	**-0.15**	**0.08**	**0.23**** **(2.02)**

Panel B: Excess Returns - HY Bonds

	Pre-Leverage Ratio			Leverage Ratio		
Porfolio	Non-Quarter-End Month	Quarter-End Month	Δ	Non-Quarter-End Month	Quarter-End Month	Δ
Constrained	-0.36 (1.33)	0.99 (1.35)		-1.23 (1.41)	-0.18 (1.96)	
Unconstrained	-0.07 (1.10)	0.85 (1.30)		-0.97 (1.27)	-0.22 (1.87)	
Constrained - Unconstrained	**-0.29**	**0.14**	**0.43**** **(2.19)**	**-0.26**	**0.04**	**0.30*** **(1.84)**

Table 5
Fund Performance by Regulatory Period

This table reports OLS estimates for panel regressions of fund alpha (in percent). 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 in month t, $BOND_t$ is the excess return on the U.S. aggregate bond index in month t, DEF_t is the return spread between the high-yield bond index and the intermediate government bond index in month t, and $OPTION_t$ is the return spread between the GNMA mortgage-backed security index and the intermediate government bond index in month t. 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. All fund-level controls are as of the end of month $t-1$. All columns include Morningstar's fund category-month fixed effects, and fund controls, including lagged flow, lagged alpha, broker affiliation dummy, age, size, family size, institutional share class fraction, and 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). $\mathbb{1}[LSFund]$ is an indicator that is one if the fund is defined as liquidity supplying and zero otherwise. $\mathbb{1}[LR]$ is an indicator that is one for months during the leverage ratio period, which goes from 01/2015 to 12/2019. The Taper Tantrum period is defined as the period from May to September 2013. Standard errors, double-clustered at the fund family and month level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Fund specialization	All Funds	IG-Focused Funds		HY-Focused Funds	
	(1)	(2)	(3)	(4)	(5)
$\mathbb{1}[LS\,Fund]$	0.006	-0.000	-0.003	0.021	0.029
	(0.009)	(0.009)	(0.010)	(0.019)	(0.019)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[LR]$	0.008	**0.022****	**0.025****	-0.012	-0.019
	(0.010)	**(0.011)**	**(0.011)**	(0.020)	(0.021)
R-Squared	0.41	0.44	0.45	0.41	0.41
Observations	66,510	41,297	39,252	25,031	23,767
Fund cat. x Period FE	✓	✓	✓	✓	✓
Taper Period Excluded	–	–	✓	–	✓
Fund controls	✓	✓	✓	✓	✓

Table 6
Within-Quarter Changes in Fund Performance

This table reports OLS estimates for panel regressions of fund alpha (in percent) on fund liquidity supply indicators. 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 in month t, $BOND_t$ is the excess return on the U.S. aggregate bond index in month t, DEF_t is the return spread between the high-yield bond index and the intermediate government bond index in month t, and $OPTION$ is the return spread between the GNMA mortgage-backed security index and the intermediate government bond index in month t. 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. All fund-level controls are as of the end of month $t-1$. 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, effective duration, natural log of 1 + average bond issue size, and natural log of 1 + average bond age), and time-varying fund characteristic (age, size, family size, institutional share class fraction, and average maximum rear load). $\mathbb{1}[LSFund]$ is an indicator that is one if the fund is defined as liquidity supplying and zero otherwise. $\mathbb{1}[LR]$ is an indicator that is one for months during the leverage ratio period, which goes from 01/2015 to 12/2019. Standard errors, double-clustered at the fund family and month level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Month of Quarter	Month 1			Month 2 & 3		
Fund specialization	All	IG-Focused	HY-Focused	All	IG-Focused	HY-Focused
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[LS\,Fund]$	0.018*	0.010	0.035	0.001	-0.007	0.016
	(0.010)	(0.012)	(0.023)	(0.011)	(0.010)	(0.021)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[LR\,Period]$	0.017	**0.033****	-0.012	0.004	0.016	-0.013
	(0.012)	**(0.016)**	(0.027)	(0.012)	(0.012)	(0.023)
R-Squared	0.38	0.44	0.36	0.42	0.44	0.43
Observations	21,692	13,325	8,306	45,348	28,324	16,896
Fund cat. x Period FE	✓	✓	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓	✓	✓

Table 7
Fund Liquidity Provisioning by Bank-Affiliated Funds

This table displays estimates for the regression:

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

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 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 and zero otherwise. $\mathbb{1}[Bank-aff.]$ is an indicator that is one if either the fund management company or the fund advisor is affiliated with a constrained bank dealer. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, 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), and time-varying fund characteristics (age, size, family size, institutional share class fraction, and average maximum rear load). $M_{j,t}$ represents bond controls and includes bond age, bond maturity, downgrade and upgrade indicators, an indicator that is one if the bond is investment-grade and zero otherwise, and the effective bid-ask spread. All controls are as of the end of period $t-1$. $\eta_j \times \lambda_y$ are bond-year fixed effects. The sample includes only LS funds during the leverage ratio period (01/2015-12/2019). Standard errors, double-clustered at the fund family and quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Fund Type	LS Funds		
Bond Type	All	IG	HY
	(1)	(2)	(3)
$\mathbb{1}[QE]$	0.094**	0.059*	0.223**
	(0.042)	(0.034)	(0.093)
$\mathbb{1}[Constr.\,Bond]$	0.080	0.054	0.177**
	(0.047)	(0.034)	(0.065)
$\mathbb{1}[Bank-aff.]$	0.002	-0.056	0.268
	(0.131)	(0.132)	(0.195)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond]$	**0.112****	**0.096****	0.103
	(0.053)	**(0.042)**	(0.073)
$\mathbb{1}[QE] \times \mathbb{1}[Bank-aff.]$	-0.312	-0.204	-0.656***
	(0.213)	(0.205)	(0.195)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Bank-aff.]$	-0.105	-0.110	-0.156**
	(0.084)	(0.088)	(0.073)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond] \times \mathbb{1}[Bank-aff.]$	-0.024	0.022	0.042
	(0.095)	(0.102)	(0.103)
R-Squared	0.10	0.09	0.11
Observations	1,780,885	1,354,832	425,893
Bond x Year FE	✓	✓	✓
Bond Controls	✓	✓	✓
Fund Controls	✓	✓	✓

Table 8
Fund Performance by Bank-Affiliated Funds and Regulatory Period

This table displays OLS estimates for the regression:

$$\alpha_{i,t} = \beta_0 + \beta_1 \mathbb{1}[LS\,Fund] + \beta_2 \mathbb{1}[Bank - aff.] \\ + \beta_3 \mathbb{1}[LS\,Fund] \times \mathbb{1}[Bank - aff.] + \theta' \mathbf{M_{i,t}} + \eta_c \times \lambda_t + \epsilon_{i,t}.$$

The dependent variable, $\alpha_{i,t}$, represents the monthly fund alpha. $\mathbb{1}[LS - Fund]$ is an indicator that is one if the fund is defined as liquidity supplying and zero otherwise. $\mathbb{1}[Bank - aff.]$ is an indicator that is one if either the fund management company or the fund advisor is affiliated with a constrained bank dealer. Fund controls, $M_{i,t}$, include lagged flow, broker affiliation dummy, 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), and time-varying fund characteristics (age, size, family size, institutional share class fraction, and average maximum rear load). All fund controls are as of the end of month $t - 1$. All specifications include fund category-time fixed effects, $\eta_c \times \lambda_t$. Columns 1-3 consider the pre-leverage ratio period (01/2010-12/2014), and columns 4-6 consider the leverage ratio period (01/2015-12/2019). Standard errors, double-clustered at the fund family and month level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Pre-Leverage Ratio			Leverage Ratio		
Fund specialization	All	IG-Focused Funds	HY-Focused Funds	All	IG-Focused Funds	HY-Focused Funds
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[LS\,Fund]$	0.010	0.001	0.022	0.011**	0.011*	0.012
	(0.009)	(0.010)	(0.019)	(0.005)	(0.006)	(0.010)
$\mathbb{1}[Bank - aff.]$	0.037*	0.020	0.070*	-0.001	-0.008	0.003
	(0.022)	(0.022)	(0.036)	(0.014)	(0.009)	(0.035)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Bank - aff.]$	0.016	0.017	0.016	-0.005	**0.034****	-0.059
	(0.023)	(0.021)	(0.054)	(0.011)	**(0.017)**	(0.037)
R-Squared	0.43	0.47	0.41	0.39	0.42	0.41
Observations	29,686	18,950	10,665	36,616	22,175	14,330
Fund cat. x Period FE	✓	✓	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓	✓	✓

Table 9
Fund 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 fund's performance:

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

The dependent variable, $\mathbb{1}[LS\_score_{i,t} > 0]$, represents 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 last 12 months (measured as the rolling average fund alpha across all LS funds in percent). $Fund\, Flow_{i,t-1,t-12}$ denotes the average flows (in % of beginning-of-month fund TNA) 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. $\mathbf{M_{i,t}}$ 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, effective 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, institutional share class fraction, and average maximum rear load). All fund-level controls are as of the end of month $t-1$. η_c refers to fund category fixed effects. The sample period is from January 2010 to December 2019. Column 1 considers all sample funds over the full sample period. Columns 2-4 consider the pre-leverage ratio period (01/2010 - 12/2014). Columns 4-6 consider the leverage ratio period (01/2015 - 12/2019). Standard errors, double-clustered at the fund family and month level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	All	Pre-Leverage Ratio			Leverage Ratio		
Fund Type	All Funds	All Funds	IG-Foc. Funds	HY-Foc. Funds	All Funds	IG-Foc. Funds	HY-Foc. Funds
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$LS\, Fund\, Performance_{t-1,t-12}$	0.066	-0.104	-0.044	-0.217	**0.451****	**0.492****	0.360
	(0.092)	(0.084)	(0.105)	(0.132)	**(0.208)**	**(0.253)**	(0.216)
$Fund\ Flow_{i,t-1,t-12}$	0.167***	0.148**	-0.011	0.318***	0.222***	0.192**	0.220
	(0.048)	(0.065)	(0.076)	(0.094)	(0.079)	(0.086)	(0.134)
$\mathbb{1}[Bank - aff.]$	-0.010	-0.020	-0.011	-0.060	-0.006	-0.008	0.017
	(0.013)	(0.015)	(0.018)	(0.046)	(0.017)	(0.024)	(0.020)
R-Squared	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Observations	52,728	23,583	14,935	8,647	29,145	17,676	11,469
Fund cat. FE	✓	✓	✓	✓	✓	✓	✓
Fund controls	✓	✓	✓	✓	✓	✓	✓

Table 10
Net Liquidity Supply over Mean Dealer Inventories in Investment-Grade Bonds

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. Every month from January 2010 to December 2019, liquidity-supplying funds' monthly position changes are used to determine their net liquidity supply in a given bond. Net liquidity supply is defined as the dollar par amount supplied minus the dollar par amount demanded divided by the dealer sector's mean inventory in a given bond over a given month. The resulting ratio is reported in percent. Volume-weighted 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 changes) and quarter-end months (months 3,6,9,12) 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 weights. Standard errors, double-clustered at the bond and year-month level, 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	9.46***	7.49*	-0.11	16.28***
	(3.52)	(4.42)	(2.54)	(4.91)
Unconstrained	6.61	2.56	-1.21	-12.93
	(4.35)	(4.30)	(3.58)	(7.98)

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	4.51***	1.82	-0.13	7.57***
	(1.47)	(1.51)	(1.37)	(2.91)
Unconstrained	1.48	-0.25	-2.23	-10.23
	(1.85)	(1.10)	(1.72)	(4.20)

Table 11
Bond Liquidity and Outflows from the Mutual Fund Industry

This table displays OLS estimates for the regression:

$$Illiquidity_{j,t} = \beta_1 \mathbb{1}[QE] + \beta_2 \mathbb{1}[Flow_t \in [0\%, 20\%]] + \beta_3 \mathbb{1}[Flow_t \in [0\%, 20\%]] \times \mathbb{1}[QE] + \gamma' \mathbf{M_{j,t}} + \eta_s + \lambda_q + \varepsilon_{j,t}.$$

The dependent variable, $Illiquidity_{j,t}$, represents the monthly bond illiquidity. $\mathbb{1}[QE]$ is an indicator that is one during the last month of a quarter. and zero otherwise $\mathbb{1}[Flow \in [0\%, 20\%]]$ is an indicator that is one if the aggregate fund flows are in the bottom 20 percent during month t and zero otherwise. $\mathbb{1}[Constrained]$ is an indicator that is one if the bond is defined as constrained during month t and zero otherwise. $\mathbf{M_{j,t}}$ denotes a vector of monthly bond-level controls including the bond maturity, bond issue size, bond age, as well as upgrade and downgrade indicators. η_s denotes issuer fixed effects, and λ_q denotes quarter fixed effects. The sample time period is 01/2010-12/2019. Columns 1 to 4 consider the subsample of unconstrained bonds, while columns 5 to 8 consider the subsample of constrained bonds. Standard errors, clustered by quarter, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Dependent Variable	Monthly Illiquidity$_{j,t}$							
Bond Constraints	Unconstrained Bonds				Constrained Bonds			
Regualtory Period	Pre-Leverage Ratio		Leverage Ratio		Pre-Leverage Ratio		Leverage Ratio	
Bond Type	IG	HY	IG	HY	IG	HY	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agg. Flows$_t$	-4.610***	-4.927***	0.125	-2.643**	-3.695***	-4.379***	-0.743	-2.254
	(1.259)	(0.876)	(1.044)	(1.192)	(1.108)	(0.819)	(1.593)	(1.426)
ln(1 + Bond age)	27.921***	26.693***	18.521***	21.988***	17.373***	22.226***	12.104***	16.270***
	(1.355)	(1.799)	(0.581)	(0.943)	(1.404)	(1.740)	(0.683)	(0.897)
ln(1 + Bond issue size)	-29.884***	-19.699***	-24.582***	-16.580***	-16.398***	-11.151***	-16.323***	-9.766***
	(1.209)	(1.691)	(0.798)	(0.648)	(1.085)	(0.985)	(0.829)	(0.919)
ln(1 + Bond maturity)	45.747***	37.581***	32.902***	30.515***	32.518***	26.617***	24.175***	22.186***
	(2.087)	(1.583)	(1.389)	(1.132)	(1.593)	(0.914)	(1.266)	(1.007)
$\mathbb{1}[Upgrade]$	-1.746	-2.048	2.440	-0.743	1.976	-4.179	-1.724	8.584
	(2.770)	(3.314)	(1.651)	(2.745)	(2.874)	(3.242)	(3.024)	(5.009)
$\mathbb{1}[Downgrade]$	13.334***	6.396*	13.041**	7.473***	15.855***	7.252*	6.582	9.557**
	(3.565)	(3.269)	(4.910)	(2.538)	(5.031)	(3.969)	(4.758)	(3.423)
$\mathbb{1}[QE]$	-1.317	0.791	-1.523*	-1.275	0.224	-0.439	-1.340*	-1.499*
	(1.233)	(1.198)	(0.752)	(0.902)	(1.252)	(1.082)	(0.690)	(0.862)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	-0.359	-1.078	1.769	0.586	-0.372	-3.810	1.698	-0.145
	(3.440)	(1.811)	(2.425)	(2.274)	(2.181)	(2.492)	(2.391)	(2.061)
$\mathbb{1}[QE] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	7.155	0.837	1.266	5.638	4.617	**7.221****	**6.180*****	**5.953****
	(4.655)	(3.086)	(3.259)	(3.363)	(4.305)	**(3.106)**	**(2.066)**	**(2.581)**
R-Squared	0.51	0.53	0.47	0.54	0.45	0.45	0.40	0.50
Observations	131,227	54,587	185,754	68,571	33,245	20,145	44,398	27,268
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓

Table 12
Bond Returns and Outflows from the Mutual Fund Industry

This table displays OLS estimates for the regression:

$$\begin{aligned} Excess\,Return_{j,t}\,(\%) &= \beta_1\, Matched\ Ret_t + \beta_2\, Matched\,Index\,Ret_t \times ln(1 + Bond\,maturity_{j,t}) \\ &+ \beta_3\, \mathbb{1}[Constrained_{j,t}] + \beta_4\, \mathbb{1}[Flow_t \in\ [0\%, 20\%]] \\ &+ \beta_5\, \mathbb{1}[Flow_t \in\ [0\%, 20\%]] \times \mathbb{1}[Constrained_{j,t}] + \gamma'\, \mathbf{M_{j,t}} + \eta_s + \lambda_q + \varepsilon_{j,t}. \end{aligned}$$

The dependent variable, $Excess\,Return_{j,t}$, represents the monthly bond return in excess of the one-month Treasury bill rate (in %). $Matched\ Ret_t$ represents the matched index return depending on the credit rating of the matched bond. $\mathbb{1}[Constrained_{j,t}]$ 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. $\mathbf{M_{j,t}}$ denotes a vector of bond-level controls including the bond maturity, bond issue size, bond age, as well as upgrade and downgrade indicators. η_s denotes issuer fixed effects, and λ_q denotes quarter fixed effects. The sample period is 01/2010-12/2019. Standard errors, clustered by month, are in parentheses. *, **, and *** indicate statistical significance at the 10 %, 5% and 1% levels.

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Table 12 - continued

Dependent Variable	Excess Bond Return (%)			
Regulatory Period	Pre-Leverage Ratio		Leverage Ratio	
Bond Type	IG	HY	IG	HY
	(1)	(2)	(3)	(4)
Matched Ret_t	-0.402***	-0.296**	-0.594***	-0.201
	(0.140)	(0.131)	(0.125)	(0.148)
Matched Ret_t × ln(1 + Bond maturity)	0.322**	0.112*	0.420***	0.274***
	(0.114)	(0.060)	(0.098)	(0.053)
$\mathbb{1}[Constrained_{j,t}]$	0.027	0.130**	0.076**	0.094*
	(0.028)	(0.054)	(0.031)	(0.046)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	0.009	0.731	-0.471	-0.574
	(0.647)	(0.811)	(0.736)	(0.735)
$\mathbb{1}[Constrained_{j,t}] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	-0.006	-0.136	**-0.246****	0.069
	(0.111)	(0.086)	**(0.090)**	(0.110)
Agg. Flows_t	0.246	1.427***	0.070	0.905
	(0.354)	(0.336)	(0.344)	(0.735)
ln(1 + Bond maturity)	0.039	0.087	-0.077	-0.075
	(0.113)	(0.090)	(0.065)	(0.064)
ln(1 + Bond age)	-0.139***	-0.174***	-0.103***	-0.068
	(0.019)	(0.043)	(0.016)	(0.056)
ln(1 + Bond issue size)	-0.009	-0.042	0.004	-0.003
	(0.016)	(0.031)	(0.013)	(0.037)
$\mathbb{1}[Upgrade]$	0.321***	-0.001	0.408***	-0.162
	(0.086)	(0.127)	(0.136)	(0.171)
$\mathbb{1}[Downgrade]$	-0.143	-0.555***	-1.225	-0.791**
	(0.275)	(0.158)	(0.710)	(0.365)
R-Squared	0.19	0.24	0.32	0.25
Observations	217,269	91,893	301,599	110,534
Issuer FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓

Table 13
Changes in Bond Illiquidity around the COVID-19 Outbreak

This table displays OLS estimates for the cross-sectional regression:

$$\Delta Illiquidity_{j,\,03/2020-02/2020} = \beta_1\,\mathbb{1}[Constrained_{j,\,02/2020}] + \eta_s + \varepsilon_j.$$

The dependent variable, $\Delta Illiquidity_{j,\,03/2020-02/2020}$, denotes the difference between the average illiquidity in the first 22 days in March 2020 and the average illiquidity in February 2020. 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. In March 2020, we end the computation of the illiquidity measure before the announcement of the Secondary Market Corporate Credit Facility (SMCCF) by the Federal Reserve on March 23, 2020. $\mathbb{1}[Constrained_{j,02/2020}]$ is an indicator that is one if the bond is defined as constrained in February 2020. η_s denotes issuer fixed effects. Standard errors, clustered by issuer, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Dependent Variable	$\Delta Illiquidity_{j,\,03/2020-02/2020}$		
Bond Type	All	IG	HY
	(1)	(2)	(3)
$D_{constrained\,02/2020}$	**9.244****	**11.895****	-1.887
	(4.552)	**(5.552)**	(7.172)
R-Squared	0.27	0.23	0.42
Observations	3,335	2,605	700
Issuer FE	✓	✓	✓

Table 14
Leverage Constraints and Bond Illiquidity and Returns around the COVID-19 Outbreak

This table displays OLS estimates for the panel regression:

$$Y_{j,t} = \beta_1 \mathbb{1}[March\ 2020] + \beta_2 \mathbb{1}[Constrained_{j,t-1}] + \beta_3 \mathbb{1}[Constrained_{j,t-1}] \times \mathbb{1}[March\ 2020] + \eta_j + \varepsilon_{j,t}.$$

The dependent variable, $Y_{j,t}$, represents the average illiquidity of bond j in month t (columns 1 to 3) and the monthly excess return of bond j in month t (columns 4 to 6.) We proxy 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. In March 2020, we end the computation of the illiquidity measure 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. η_j denotes bond fixed effects. The sample time period is 01/02/2020-22/03/2020. Standard errors, clustered by issuer, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Dependent Variable	Monthly Illiquidity$_{j,t}$			Excess Bond Return$_{j,t}$ (%)		
Bond Specification	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[March\,2020]$	92.005***	99.072***	68.785***	-6.010***	-6.034***	-5.858***
	(2.183)	(2.573)	(3.621)	(0.079)	(0.091)	(0.152)
$\mathbb{1}[Constrained_{j,t-1}]$	-1.949	-6.631	-0.362	1.222***	1.685***	0.274
	(3.835)	(5.025)	(5.100)	(0.145)	(0.160)	(0.288)
$\mathbb{1}[March\,2020] \times \mathbb{1}[Constrained_{j,t-1}]$	3.625	**18.205***	-7.532	**-2.144***	**-2.954***	-0.667*
	(4.959)	**(6.226)**	(7.480)	**(0.201)**	**(0.217)**	(0.397)
R-Squared	0.73	0.77	0.79	0.78	0.79	0.80
Observations	7,806	5,716	2,090	11,032	8,442	2,384
Bond FE	✓	✓	✓	✓	✓	✓

Appendix

Table A1
Covariate Balance in Propensity Score Matched Sample

This table displays covariate balance statistics for the one-to-one matched bond sample, separating 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 estimated propensity score. *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	142,803	1.08	0.62	142,803	1.13	0.62	0.09
Bond maturity	142,803	2.09	0.71	142,803	2.04	0.72	0.06
Bond issue size	142,803	13.42	0.63	142,803	13.40	0.63	0.05
Bond rating (1 = AAA)	142,803	10.53	5.17	142,803	10.45	5.82	0.02
Bond illiquidity (bp)	142,803	40.72	51.22	142,803	41.77	53.56	0.02

Table A2
Determinants of Bond Constrainedness

This table displays average logistic regression estimates for the monthly cross-sectional regression:

$$ln(\frac{p}{1-p}) = \beta_0 + \beta_{Age}\, ln(1 + Bond\, Age_{j,t}) + \beta_{Maturity}\, ln(1 + Bond\, Maturity_{j,t}) + \beta_{Size}\, ln(1 + Issue\, Size_{j,t}) + \beta_{Rating}\, Rating_{j,t} + \beta_{Illiquidity}\, Illiquidity_{j,t} + \epsilon_{j,t}$$

The dependent variable represents the probability that a bond is classified as constrained. *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 are reported in parantheses.

Average Coefficients				
$\hat{\beta}_{Age}$	$\hat{\beta}_{Maturity}$	$\hat{\beta}_{Size}$	$\hat{\beta}_{Rating}$	$\hat{\beta}_{Illiquidity}$
-0.620***	0.301***	0.175*	0.152	-0.228***
(0.000)	(0.000)	(0.061)	(0.105)	(0.008)

Table A3
LS Fund Liquidity Provisioning - Q1-3 vs. Q4

This table displays estimates for the regression:

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

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in position 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. $\mathbb{1}[Constr.\,Bond]$ 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, institutional share class fraction, 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, an indicator that is one if the bond is investment-grade and zero otherwise, 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 $t-1$. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample period is restricted to the leverage ratio period (01/2015 - 12/2019). We further restrict the sample to only LS funds. Columns 1-3 report the estimates for quarters 1-3. Columns 4-6 report the estimates for quarter 4. Standard errors, double-clustered at the fund family and quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Quarter	Quarter 1-3			Quarter 4		
Bond Type	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{1}[QE]$	0.072	0.050	0.136	0.145	0.117	0.277
	(0.057)	(0.048)	(0.133)	(0.069)	(0.070)	(0.135)
$\mathbb{1}[Constr.Bond]$	0.068	0.046	0.135*	0.050	0.041	0.069
	(0.043)	(0.030)	(0.073)	(0.044)	(0.038)	(0.108)
$\mathbf{1}[QE] \times \mathbb{1}[Constr.Bond]$	0.106	**0.093***	0.115	-0.118	-0.111	-0.096
	(0.067)	**(0.049)**	(0.092)	(0.084)	(0.086)	(0.132)
R-Squared	0.12	0.11	0.13	0.17	0.15	0.20
Observations	1,330,236	1,011,106	319,000	460,944	353,998	106,904
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table A4
Liquidity Provisioning Before and After Basel III - Q1-3 vs. Q4

This table displays estimates for the regression:

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

The dependent variable, $Fund\,Position\,Change_{i,j,t}$, represents the change in bond j position of fund i at time 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. $\mathbb{1}[LS\,Fund]$ 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 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, 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), and time-varying fund characteristic (age, size, family size, institutional share class fraction, and average maximum rear load). $M_{j,t}$ represents bond controls and includes the bond age, bond maturity, downgrade and upgrade indicators, an indicator that is one if the bond is investment grade and zero otherwise, and the 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 $t-1$. $\eta_j \times \lambda_y$ represents bond-year fixed effects. The sample period is the leverage ratio period (01/2015 - 12/2019). Columns 1-3 report the estimates for quarters 1-3. Columns 4-6 report the estimates for quarter 4. Standard errors, double-clustered at the fund family and quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Quarter 1-3			Quarter 4		
Bond Rating	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.048	0.043	0.061	0.132**	0.161**	0.115
	(0.036)	(0.035)	(0.049)	(0.045)	(0.051)	(0.070)
$\mathbb{1}[LS\,Fund]$	0.059	0.028	0.134**	0.055	0.045	0.110
	(0.034)	(0.031)	(0.049)	(0.051)	(0.034)	(0.112)
$\mathbb{1}[Constr.\,Bond]$	0.051	0.048	0.069	-0.019	0.036	-0.064
	(0.041)	(0.041)	(0.055)	(0.053)	(0.054)	(0.074)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[QE]$	0.056	0.041	0.070	0.092	0.016	0.226
	(0.053)	(0.044)	(0.110)	(0.068)	(0.036)	(0.175)
$\mathbb{1}[Constr.\,Bond] \times \mathbb{1}[QE]$	-0.012	-0.046	0.026	-0.276*	-0.399*	-0.132
	(0.060)	(0.061)	(0.064)	(0.117)	(0.152)	(0.121)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Constr.\,Bond]$	0.059	0.027	0.100*	0.099	0.039	0.158*
	(0.075)	(0.088)	(0.048)	(0.052)	(0.054)	(0.070)
$\mathbb{1}[LS\,Fund] \times \mathbb{1}[Constr.\,Bond] \times \mathbb{1}[QE]$	0.120**	**0.139****	0.081	0.112	**0.184***	-0.027
	(0.053)	**(0.048)**	(0.068)	(0.075)	**(0.069)**	(0.082)
R-Squared	0.10	0.09	0.11	0.14	0.13	0.15
Observations	3,774,778	2,364,037	1,410,676	1,296,529	821,299	475,206
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table A5
Quarter-End Liquidity Provisioning - Propensity Score Matched Sample

This table reproduces Table 3 in the matched sample of constrained and unconstrained bonds. The sample period is 01/2010 - 12/2019. Columns 1-3 restrict the sample to the pre-leverage ratio period (01/2010-12/2014). Columns 4-6 restrict the sample to 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 value (AAA = 1); *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, without replacement, to the unconstrained bond in month t with the smallest absolute distance based on estimated propensity score. Standard errors, double-clustered at the fund family and quarter level, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Regulatory Period	Pre-Leverage Ratio			Leverage Ratio		
Bond Rating	All	IG	HY	All	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{1}[QE]$	0.163**	0.142	0.174**	0.090***	0.071*	0.113**
	(0.073)	(0.091)	(0.079)	(0.031)	(0.035)	(0.046)
$\mathbb{1}[LS-Fund]$	0.132*	0.103	0.108	0.093***	0.068**	0.111**
	(0.073)	(0.090)	(0.086)	(0.030)	(0.030)	(0.048)
$\mathbb{1}[Constr.\,Bond]$	0.159***	-0.002	0.320***	0.035	-0.002	0.092*
	(0.049)	(0.061)	(0.082)	(0.037)	(0.042)	(0.050)
$\mathbb{1}[QE] \times \mathbb{1}[LS-Fund]$	-0.034	-0.138	0.161	0.078*	0.041	0.181
	(0.086)	(0.083)	(0.155)	(0.044)	(0.036)	(0.108)
$\mathbb{1}[QE] \times \mathbb{1}[Constr.\,Bond]$	-0.053	0.033	-0.148	-0.014	-0.018	-0.005
	(0.061)	(0.084)	(0.097)	(0.048)	(0.055)	(0.051)
$\mathbb{1}[LS-Fund] \times \mathbb{1}[Constr.\,Bond]$	0.153	0.178	0.198**	0.063	0.044	0.128**
	(0.098)	(0.130)	(0.082)	(0.069)	(0.079)	(0.051)
$\mathbb{1}[QE] \times \mathbb{1}[LS-Fund] \times \mathbb{1}[Constr.\,Bond]$	0.045	0.002	0.029	0.069	**0.089****	-0.021
	(0.051)	(0.066)	(0.106)	(0.051)	**(0.040)**	(0.075)
R-Squared	0.16	0.15	0.17	0.11	0.11	0.13
Observations	1,602,708	855,499	747,170	2,560,857	1,499,796	1,061,039
Bond x Year FE	✓	✓	✓	✓	✓	✓
Bond Controls	✓	✓	✓	✓	✓	✓
Fund Controls	✓	✓	✓	✓	✓	✓

Table A6
Bond Liquidity and Outflows from the Mutual Fund Industry - Propensity Score Matched Sample

This table reproduces Table 11 in the matched sample of constrained and unconstrained bonds.The sample time period is 01/2010-12/2019. Columns 1 to 4 consider the subsample of unconstrained bonds, while columns 5 to 8 consider the subsample of constrained bonds. 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 value (AAA = 1); *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, without replacement, to the unconstrained bond in month t with the smallest absolute distance based on estimated propensity score. Standard errors, clustered by quarter, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels.

Dependent Variable	Monthly Illiquidity$_{j,t}$							
Bond Constraints	Unconstrained Bonds				Constrained Bonds			
Regualtory Period	Pre-Leverage Ratio		Leverage Ratio		Pre-Leverage Ratio		Leverage Ratio	
Bond Type	IG	HY	IG	HY	IG	HY	IG	HY
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Agg. Flows$_t$	-3.477***	-4.354***	-0.139	-1.508	-3.616***	-4.330***	-0.660	-2.302
	(0.991)	(0.855)	(1.181)	(1.404)	(1.092)	(0.810)	(1.610)	(1.353)
ln(1 + Bond age)	18.432***	20.196***	13.237***	12.484***	16.981***	22.020***	11.953***	16.290***
	(1.127)	(1.836)	(0.679)	(1.316)	(1.395)	(1.769)	(0.708)	(0.890)
ln(1 + Bond issue size)	-16.466***	-10.647***	-16.325***	-7.215***	-16.179***	-11.471***	-16.274***	-9.900***
	(1.112)	(1.354)	(0.902)	(1.059)	(1.022)	(1.020)	(0.846)	(0.921)
ln(1 + Bond maturity)	33.025***	29.225***	25.203***	20.254***	32.493***	26.707***	24.273***	22.448***
	(1.563)	(1.615)	(1.161)	(0.990)	(1.617)	(0.894)	(1.269)	(1.000)
$\mathbb{1}[Upgrade]$	3.274	-2.110	-1.826	1.962	2.454	-2.933	-1.073	9.958*
	(2.478)	(5.127)	(2.514)	(2.880)	(3.100)	(3.163)	(3.161)	(5.070)
$\mathbb{1}[Downgrade]$	26.834***	-6.192	2.208	8.306***	19.182***	6.350	6.578	9.707**
	(5.658)	(6.106)	(4.280)	(2.853)	(5.044)	(3.954)	(4.619)	(3.529)
$\mathbb{1}[QE]$	-0.369	0.703	-1.114	3.644***	0.389	-0.663	-1.349*	-1.469
	(1.274)	(1.335)	(0.761)	(0.655)	(1.282)	(1.055)	(0.679)	(0.863)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	1.673	-3.008	0.753	3.743	-0.088	-3.703	1.667	-0.388
	(3.273)	(2.336)	(2.141)	(2.269)	(2.248)	(2.512)	(2.522)	(1.959)
$\mathbb{1}[QE] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	6.923	2.153	1.857	3.847	4.488	**7.174****	**6.112*****	**6.224****
	(4.549)	(3.957)	(2.167)	(2.321)	(4.279)	**(3.046)**	**(2.031)**	**(2.579)**
R-Squared	0.47	0.48	0.42	0.56	0.46	0.46	0.41	0.51
Observations	32,884	16,269	47,011	20,220	31,885	19,485	43,150	26,672
Issuer FE	✓	✓	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓	✓	✓	✓	✓

Table A7
Bond Returns and Outflows from the Mutual Fund Industry - Propensity Score Matched Sample

This table reproduces Table 12 in the matched sample of constrained and unconstrained bonds. The sample period is 01/2010-12/2019. 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 value (AAA = 1); *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, without replacement, to the unconstrained bond in month t with the smallest absolute distance based on estimated propensity score. Standard errors, clustered by quarter, are in parentheses. *, **, and *** indicate statistical significance at the 10 %, 5% and 1% levels.

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Table A7 - continued

Dependent Variable	Excess Bond Return (%)			
Regulatory Period	Pre-Leverage Ratio		Leverage Ratio	
Bond Type	IG	HY	IG	HY
	(1)	(2)	(3)	(4)
Matched Ret_t	-0.493***	-0.304**	-0.678***	-0.131
	(0.151)	(0.141)	(0.146)	(0.160)
Matched Ret_t × ln(1 + Bond maturity)	0.368***	0.129*	0.447***	0.230***
	(0.123)	(0.062)	(0.109)	(0.058)
$\mathbb{1}[Constrained_{j,t}]$	-0.005	0.050	0.057*	0.010
	(0.021)	(0.045)	(0.029)	(0.070)
$\mathbb{1}[Flow \in [0\%, 20\%)]$	0.017	0.847	-0.730	-0.454
	(0.745)	(0.843)	(0.830)	(0.713)
$\mathbb{1}[Constrained_{j,t}] \times \mathbb{1}[Flow \in [0\%, 20\%)]$	-0.064	-0.098	**-0.167*****	0.051
	(0.048)	(0.091)	**(0.058)**	(0.121)
Agg. Flows_t	0.295	1.498***	-0.001	0.834
	(0.447)	(0.354)	(0.409)	(0.731)
ln(1 + Bond age)	-0.121***	-0.082*	-0.037*	0.035
	(0.020)	(0.045)	(0.021)	(0.060)
ln(1 + Bond issue size)	0.013	-0.063*	0.008	0.013
	(0.023)	(0.032)	(0.017)	(0.041)
ln(1 + Bond maturity)	0.036	0.018	-0.081	-0.061
	(0.129)	(0.106)	(0.070)	(0.071)
$\mathbb{1}[Upgrade]$	0.445***	-0.013	0.384**	-0.275
	(0.098)	(0.160)	(0.142)	(0.225)
$\mathbb{1}[Downgrade]$	-0.419	-0.700***	-1.067*	-0.648**
	(0.338)	(0.215)	(0.540)	(0.285)
R-Squared	0.18	0.23	0.32	0.25
Observations	73,469	40,757	100,165	50,400
Issuer FE	✓	✓	✓	✓
Quarter FE	✓	✓	✓	✓