The Consequences of Fund-level Liquidity Requirements*

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Abstract

We investigate the effects of mandatory mutual fund liquidity requirements on fund fragility. After the implementation of SEC Rule 22e-4, as required, bond mutual funds hold more liquid securities. However, we find that additional liquidity does not ameliorate fragility. Post-rule, funds with illiquid securities face greater outflows conditional on past underperformance, and fund exits increase. At the holdings level, funds exhibit a higher likelihood of selling illiquid securities post-rule. In turn, such sales increase fund underperformance, thus completing the vicious cycle of fragility. These results are consistent with the theory that fund-level liquidity does not necessarily reduce fund-run incentives.

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1 Introduction

Liquidity mismatch between assets and liabilities is a concern for open-end mutual funds. Similar to the case for banks, the liquidation horizon of potentially illiquid portfolio holdings is longer than the time frame within which open-end funds are required to meet capital redemption requests. Further, such mutual funds have also faced large bank-run-like outflows in recent years.[1] Fund runs can generate correlated redemption requests across funds that, in turn, can cause asset fire sales and market-wide fragility (recent influential papers include Chen et al., 2010; Kacperczyk and Schnabl, 2013; Goldstein et al., 2017; Zeng, 2017; Claessens and Lewrick, 2021; Ma et al., 2022a,b).

In response to concerns of systemic liquidity risk, the U.S. Securities and Exchange Commission (SEC) promulgated Rule 22e-4 (the "Liquidity Rule") to improve the resilience of mutual funds. The Liquidity Rule requires that mutual funds enact liquidity risk management programs, limit the fraction of fund investment in securities classified as illiquid to a maximum of 15%, classify their holdings into liquidity "buckets," and maintain a portion of assets in "highly liquid" securities.[2]

The Liquidity Rule aims to increase fund-level liquidity. However, higher liquid holdings do not guarantee that funds will not face a run. A key insight in Zeng (2017) is that *"Runs can occur in equilibrium regardless of whether the fund starts with a high cash position or a low one. However, the nature of strategic interactions among shareholders differs between these two cases."* If fund managers deplete liquid securities to meet redemptions, this action may trigger a run on the fund (Zeng, 2017). This is because the anticipation of cash rebuilding in the future can itself generate a strategic complementarity among shareholders, which ultimately leads to runs.

[1] An example is a redemption freeze to avoid fire sales by the high-yield bond fund "Third Avenue Focused Credit Fund" in late 2015.

[2] The rule also requires disclosure of the deemed liquidity-level of held securities, and greater detail of cash holdings. Furthermore, the SEC mandates filings to be privately provided to them in the event any fund exceeds the 15% maximum. Section 2.1 provides further details on the rule.

In contrast, if fund managers face a liquidity mismatch during a crisis and sell more illiquid securities to rebuild the cash buffer, then the fund can also face shareholder runs. This second scenario is also analytically documented in Zeng (2017) and matches the empirical findings in Chen et al. (2010); Goldstein et al. (2017); Shek et al. (2017), among others.[3] Thus, given the indeterminate effect of the level of liquidity on fund runs, the final impact of the Liquidity Rule on market fragility is an empirical question.

To answer this empirical question, we examine the effect of the Liquidity Rule on bond funds in four steps. We first establish the relevance of the rule, namely whether the rule changes the overall liquid holdings of funds. Second, we investigate the effect of the rule on fund flows conditional on performance (following the framework of Goldstein et al., 2017) as well as fund exits. Third, we use holdings-level data for each fund to investigate which specific securities are sold by bond funds during a crisis. Finally, we examine the effects of the sale of specific securities on the net asset value (NAV) of funds. Thus, our analysis seeks to investigate each link in the cycle that can lead to market fragility: past fund (under)performance can trigger outflows during a crisis, outflows can induce the sale of specific holdings, and in turn, certain sales can affect fund performance. Our analysis focuses on bond funds because they are most affected by fragility concerns. We also focus on the two crisis periods—the financial crisis and COVID crisis—when market illiquidity is relatively high.

An important empirical hurdle in studies of wide-reaching regulatory changes is identification. In our specific case, since the Liquidity Rule affects all funds in the U.S., a within-U.S. analysis can only rely on cross-sectional variation in funds' exposure to the rule based on their holdings. Additionally, we must also assume that market conditions—which affect fund holdings—are similar

[3] Specifically, Chen et al. (2010) provide empirical evidence that strategic complementarities among investors generate fragility in financial markets. The authors show that mutual funds with illiquid assets, where strategic complementarities are stronger, are subject to more outflows than funds with liquid assets. Furthermore, Goldstein et al. (2017) show that bond funds exhibit a concave flow-to-performance relationship. The authors provide empirical evidence that corporate bond funds have greater sensitivity of outflows to bad performance when they have more illiquid assets and when the overall market illiquidity is high (such as during a crisis).

before and after the Liquidity Rule.

Given these challenges posed by a within-U.S. analysis, we exploit jurisdictional limitations of the SEC and rely on a difference-in-differences identification strategy. Specifically, we compare U.S.-domiciled open-end mutual funds, which must comply with the Liquidity Rule, to Canadian-domiciled open-end mutual funds, which are not regulated by the SEC. This strategy exploits the fact that mutual funds in the two countries face different regulators, but share a similar economic environment: The two financial markets are comparable, and shocks to the U.S. and Canadian financial markets are significantly correlated.

We begin our analysis by documenting that the rule had a sizable effect on the liquidity of U.S. funds. Following the adoption of the Liquidity Rule, U.S. funds increased highly liquid portfolio holdings by approximately six percentage points (pp.) relative to Canadian funds (Figure 1). Figure 2 also documents that liquidity levels are higher in the COVID crisis time period compared to the Financial Crisis period. In this and subsequent tests, we define highly liquid holdings as the sum of cash holdings, government securities, and repurchase agreements reported by Morningstar for the quarter.

As discussed above, however, more fund-level liquidity does not necessarily reduce run incentives (Zeng, 2017). Hence, we next explore whether the rule improves the resilience of funds. For this purpose, we draw on the setup from the influential work on bond fund fragility by Goldstein et al. (2017). Their paper shows that bond fund outflows are highly sensitive to underperformance. Following their framework, we estimate the change in sensitivity of outflows to fund performance around the rule. We find that after the rule change, during a crisis, U.S. fund flows increase per unit underperformance. Figure 3 shows that U.S. funds in the last two quintiles of performance suffer from additional outflows of three pp. of lagged NAV post-rule.

A natural follow-up question is whether U.S. funds also exit more often post-rule. We document a one pp. increase in the likelihood of fund exits post-rule. The results so far are in line with the theoretical findings in Zeng (2017) that investor run incentives can remain even when funds

maintain significant liquidity.

Next, we use fund-level holdings data to investigate which assets are liquidated by funds in response to redemptions. We find that before the rule, U.S. funds sold more liquid securities during market stress (the financial crisis period). This is the same pre-rule period in which Choi et al. (2020) find that U.S. corporate bond funds were able to absorb investor redemption risk without excessively liquidating corporate bonds. In contrast, we find that after the Liquidity Rule was implemented, U.S. bond mutual funds maintain higher levels of liquidity compared to before the rule.

After investigating highly liquid securities, we switch to how fixed income funds trade less liquid holdings, specifically, municipal and corporate bond holdings. The relative illiquidity of these securities compared to highly liquid securities can lead to fund fragility (Chen et al., 2010; Goldstein et al., 2017). Hence, understanding the effect of the Liquidity Rule on the trading patterns of these holdings is important. We divide corporate and municipal bond issuances into five quintiles of liquidity. We document that post-rule, U.S. funds sell more illiquid securities (Figure 4). Our findings are in line with Falato et al. (2021) who find that during the COVID crisis, fund outflows were the most severe for funds with illiquid assets that are vulnerable to fire-sale pressures.

We underscore that our findings that U.S. funds sell more illiquid holdings and maintain higher liquidity levels post-rule do not necessarily suggest that funds are worse off through such sales. However, as Zeng (2017) notes, *"cash-rebuilding implies predictable voluntary sales of illiquid assets and hence a predictable decline in NAV. This generates a first-mover advantage, leading to shareholder runs."* Indeed, in the presence of the Liquidity Rule, U.S. funds appear to make predictable sales to rebuild their cash buffers.

Hence, we next analyze the effect of such predictable sales of very illiquid securities on fund value. For this analysis, we classify securities in the bottom two quintiles as the "most illiquid" securities. We find that funds that sell an additional standard deviation (0.0429) of "most illiquid" securities have 0.70 pp. lower returns. This reduction in return is of the same order of magnitude

as one standard deviation of the return of fixed income funds in our sample. We find similar results when we use a binary variable for negative fund returns.

In sum, we document that (i) U.S. funds increase liquidity of their holdings post-rule; (ii) nevertheless, these funds experience increased fixed income fund outflows (conditional on past underperformance) and fund closures; (iii) U.S. funds have a higher likelihood of selling illiquid securities and avoiding the sale of liquid holdings post-rule; (iv) such sale of illiquid securities increases fund underperformance. Overall, the findings (i)–(iv) point towards the inability of the Liquidity Rule to prevent the vicious cycle of market fragility: past underperformance increases outflows and as funds sell more illiquid securities, such sales increase underperformance.

Our paper draws from the theoretical insights in Chen et al. (2010) and Zeng (2017). Chen et al. (2010) uses a model of global games to provide a link between payoff complementarities and financial fragility. The authors also provide empirical evidence in line with the theory, showing that funds with more illiquid assets are subject to more redemptions. Zeng (2017) shows that endogenous cash management of funds can generate shareholder runs even with a flexible NAV. The key insight from Zeng (2017) that motivates our work is that investor runs can take place in equilibrium regardless of whether a fund starts with a high liquidity position or a low one. Our work, therefore, contributes to the literature by empirically testing the effects of the Liquidity Rule on financial fragility.

Our paper relates to the literature that documents fragility in capital markets, specifically bond funds.[4] Chen et al. (2010) empirically show that conditional on low past performance, funds with illiquid assets, facing stronger strategic complementarities, are subject to more outflows than funds with liquid assets. Thus, consistent with theory, strategic complementarities among investors generate financial fragility. Goldstein et al. (2017) show that the outflows of corporate bond funds

[4]A growing literature documents fragility in money market funds as well. Kacperczyk and Schnabl (2013) document that during the 2008 Financial Crisis, money market funds (MMFs) took risk because fund inflows were responsive to fund yields. Further, MMFs suffered runs due to risk-taking. Li et al. (2021) find that liquidity restrictions exacerbated the run on prime MMFs during the COVID-19 crisis. The stress in money market funds during COVID-19 is also discussed in Goldstein et al. (2021).

are more sensitive to low performance. They also show that corporate bond funds have greater sensitivity of outflows to low performance when they have more illiquid assets, especially when the overall market illiquidity is high, such as during a crisis.

Indeed, Falato et al. (2021) document major outflows in corporate-bond funds during the COVID-19 crisis. Such outflows were the most severe for funds with illiquid assets. Ma et al. (2022a) show that fixed-income mutual funds contributed to the high selling pressure in asset markets during the COVID-19 crisis. They find that in March 2020, there was significant selling of Treasuries and highly-rated corporate bonds. Figure 9 of their paper also documents a higher outflow-liquidation sensitivity for less liquid securities (those below BBB-) which is consistent with our post-rule findings. In addition, Huang et al. (2025) find that the selling pressure in Treasuries led to volatility in that asset class. Jiang et al. (2022) also find that asset illiquidity of mutual funds introduces fragility into the corporate bond market, including during the COVID-19 crisis. In the pre-COVID period as well, Jiang et al. (2021) demonstrate that redemptions from the corporate bond fund sector lead to more corporate bond selling during high-uncertainty periods. Our paper contributes to this literature by analyzing the effects of the Liquidity Rule on fund fragility.[5]

Our paper also relates to the vast literature on liquidity provision by financial intermediaries and related regulations to improve the stability of the financial system. Traditionally, the literature has noted the role of banks as liquidity providers which issue demandable debt backed by a portfolio of illiquid assets (Diamond and Dybvig, 1983; Gorton and Pennacchi, 1990). Recent literature has also pointed to the role of intermediaries issuing demandable equity in liquidity provision. Chernenko and Sunderam (2020) studies liquidity transformation in mutual funds by investigating their cash holdings. Ma et al. (2022b) quantitatively estimate the liquidity provision by bond funds issuing demandable equity and finds that bond funds provide significant liquidity. At the same time, liquidity transformation has always been a source of fragility for financial institutions

[5]In addition, Choi et al. (2022) find evidence of widespread stale prices in bond mutual funds that can lead to fragility. Recently, Giannetti and Jotikasthira (2022) show that mutual funds with a large share of a bond issue sell their holdings of that issue to a lower extent when they experience redemptions.

(e.g., Diamond and Dybvig, 1983; Diamond and Rajan, 2001; Allen and Gale, 2005; Duarte and Eisenbach, 2021; Chen et al., 2022). In addition to the Liquidity Rule in the U.S., policymakers worldwide have tried other potential solutions. Among those, Jin et al. (2021) show that alternative pricing rules (swing pricing) eliminate the first-mover advantage arising from the traditional pricing rule and significantly reduce outflows during market stress. Our paper contributes by focusing on the specific question of how liquidity risk management can affect the fragility of bond mutual funds.

2 Regulatory Landscape, Identification Strategy, and Data

Section 2.1 discusses the circumstances that led to the Liquidity Rule in the United States. The section also discusses pertinent regulations in Canada. Next, Section 2.2 discusses our identification strategy to assess the effects of the Liquidity Rule on mutual funds. Finally, we describe the data utilized in the paper in Section 2.3.

2.1 Regulatory Landscape in the U.S. and Canada

The Liquidity Rule in the U.S.: In December 2015, Third Avenue Management LLC denied outstanding investors' redemption requests and unexpectedly placed fund assets into a liquidating trust. The SEC announced a full review of the matter. At the time of liquidation, approximately 18% of fund assets were illiquid. After the collapse of Third Avenue, the SEC proposed a rule and adopted Rule 22e-4 in 2016.[6]

The SEC Rule 22e-4 (the "Liquidity Rule") took effect in January 2017, with funds required to comply by December 2018 if their assets exceeded $1 billion. Funds with less than $1 billion had a deadline of June 2019. The Liquidity Rule required changes to both fund managers' operating activities and disclosure requirements. The SEC's mandated liquidity risk management program

[6]See "SEC Adopts Rules to Modernize Information Reported by Funds, Require Liquidity Risk Management Programs, and Permit Swing Pricing" here: https://www.sec.gov/news/press-release/2016-215.

has two key features: (i) a minimum level of investment in highly liquid assets, to be determined by the fund's board of directors; and (ii) a maximum of 15% of fund assets in "illiquid" securities.[7]

While all funds must comply with the Liquidity Rule, fixed income funds are more affected given their holdings of relatively less liquid assets, such as corporate debt of lower credit quality and municipal debt. The Liquidity Rule aims to reduce risks of a "run on the fund" (Valderrama, 2021). In this paper, we investigate whether higher levels of liquidity can indeed ensure that funds will not face a run.

Relevant Rules in Canada: We use Canadian mutual funds as a comparison group because the U.S. and Canadian markets share similar economic, legal, and cultural contexts (e.g., Leuz et al., 2003; MacGee and Rodrigue, 2024). Yet, Canada did not introduce a regulatory mandate equivalent to the SEC's Liquidity Rule over our sample period. This contrast provides a natural setting to identify the effects of Rule 22e-4 in the United States. Specifically, if we observe differential outcomes between the U.S. and Canadian funds following the rule's implementation, we can credibly attribute those differences to the new rule—rather than to broader market or global regulatory changes. Below, we briefly discuss Canadian regulations (with additional details in Appendix A). The purpose of the discussion is to confirm that there have been no major changes to Canadian fund liquidity requirements that can confound our identification strategy.

Canadian open-end mutual funds are regulated by the Canadian Securities Administrators (CSA), which is the umbrella organization of Canada's provincial regulators. In February 2000, Canada implemented a National Instrument (NI 81-102) that established a new regime governing mutual funds domiciled across Canada, harmonizing regulations across the country.[8] NI 81-102

[7]The program also requires: (1) an assessment and review of the fund's liquidity risk, (2) a minimum of a monthly review of liquidity classifications of funds portfolio investments, and (3) setting policies and procedures for handling redemptions in kind. The SEC defines liquidity risk as "...the risk that a fund could not meet requests to redeem shares issued by the fund without significant dilution of remaining investors interests in the fund." The SEC defines a security as illiquid if the security could not be converted into cash within seven business days at a price that does not substantially differ from what management valued it at on their books. Investor "dilution" occurs when the fund that holds illiquid securities must sell those securities below market value to meet redemption requests. Boards must approve the liquidity risk management program, designate the main officer to maintain the program, and review and produce a written report on the effectiveness of the program. Source: https://www.sec.gov/rules/final/2016/33-10233.pdf.

[8]See link: NIN 2000/02 - Adoption of National Instrument 81-102 Mutual Funds. A detailed description of the act

provides rules for funds' operations, including but not limited to investment restrictions on leverage, derivative products, short-selling, disclosure, and distribution. Governance of funds is also regulated under this rule, setting requirements for boards of directors, etc. These rules and regulations are similar in nature to those in the U.S. under the Investment Company Act of 1940 and its subsequent amendments. We provide a timeline in Appendix A that summarizes the regulatory environment around NI 81-102 since its initial promulgation.[9]

As mentioned above, in the U.S., the SEC imposed regulations that require funds to maintain minimum liquidity. The key portion of interest in the SEC rule is § 22e-4(b)(1)(iii) on "Highly liquid investment minimum." This provision requires mutual funds under SEC jurisdiction to maintain a minimum amount of highly liquid investments. We do not find a comparable rule in NI 81-102 in Canada.[10]

In fact, the CSA explicitly did not adopt the liquidity requirements of SEC Rule 22e-4. Specifically, during the comment period for "Modernization of Investment Fund Product Regulation" in its October 2018 Notice of Amendments, the CSA summarized comments related to Section 2.4 (Restrictions Concerning Illiquid Assets) that requested a harmonization with and adoption of the SEC's recent liquidity changes and responded as follows: "Change not made. We are not contemplating any changes to the illiquid asset thresholds for mutual funds under NI 81-102 as part of this Project." Moreover, during the post-U.S. rule period, the CSA did not introduce regulatory changes. The CSA, through a Staff Bulletin (81-333), offered reiterative commentary on existing regulations. This commentary did not result in any functional changes for Canadian funds.

As an added measure, we trace the amendments to NI 81-102 in Canada to check for potential rules that may still confound our empirical strategy. Before the Liquidity Rule was implemented in the U.S. and before the Financial Crisis, NI 81-102 was amended in the years 2001 (regarding

is linked here: Securities Act National Instrument 81-102 Investment Funds.

[9] An exhaustive repository of changes to NI 81-102 is linked here: 81-102 81-102CP - Investment Funds.

[10] See pertinent portion of SEC rule using hyperlinks: Rule 22 e-4 and compare with section on linked document: Investments in NI 81-102.

ownership concentration of funds), 2003 (regulations for fund of funds), and 2006 (conflict of interest regarding fund management). In response to the financial crisis, the Canadian regulations for mutual funds were amended in the years 2008 (regarding conformity in calculating net asset value with Canadian GAAP), and 2011 (regulations regarding fund offerings and performance). After responding to the Financial Crisis, additional amendments to NI 81-102 were made in the years 2014 (extended regulations to certain non-redeemable funds and ETFs), 2017 (standardization of risk calculation methodology and disclosure), 2019 (regulated "Alternative Funds" using derivatives and leverage), and 2020 (Staff Bulletin, 81-333, to highlight best practices in liquidity risk management without any amendment to the rules). Appendix A contains an extensive timeline. Overall, none of the regulations and amendments in Canada, while similar otherwise, include any mandate similar to the SEC minimum liquidity requirements.

2.2 Identification Strategy

We study the impact of the Liquidity Rule on fund fragility using a difference-in-differences identification strategy. This strategy requires a careful choice of both the appropriate control sample of funds and the appropriate comparison time period.

One approach is to compare within U.S. funds with differential exposure to the Liquidity Rule due to their differences in holdings ex-ante. This approach suffers from concerns that a fund's exposure to the rule and the same fund's response to shocks are endogenous to the holdings of the fund. As funds with different holdings respond to aggregate economic conditions differently, an estimated change in fund fragility due to the rule can then reflect the dynamic selection by funds into holdings that make them differentially susceptible to changing aggregate economic conditions. For example, funds with more illiquid assets are more susceptible to strategic complementarities among investors and therefore potentially more fragile (see, for example, Chen et al., 2010).

Hence, in our main analyses, we utilize a source of variation in exposure to the Liquidity Rule that is exogenous to fund holdings: jurisdictional limitations of the Securities and Exchange Com-

mission (SEC). As the SEC has regulatory authority only within the United States, we compare the holdings of U.S.-domiciled open-end mutual funds that face the Liquidity Rule to Canadian-domiciled open-end mutual funds that are unaffected by the rule. We believe that this strategy is appropriate because while U.S. funds and Canadian funds operate under different regulatory regimes, as discussed in Section 2.1, the foundations of their regulatory environments are similar. Furthermore, the two financial markets are closely related due to geographic and economic connections. Real economic activity as well as fund flows in the two countries are also highly correlated.

These differences in jurisdiction but similarities in economic environment are such that comparing U.S. mutual funds and Canadian mutual funds (first difference) before and after the adoption of the rule (second difference) should allow us to isolate the effect of the Liquidity Rule on funds' behavior. Section 2.1 carefully considers all amendments in Canada to assuage concerns that changes in the regulatory environment in the control sample may be affecting the results. As noted earlier, Canadian regulators have not set a minimum liquidity level mandate as their U.S. counterparts have. In addition, we perform U.S.-only and Canada-only tests to check that our results are present in the U.S.-only sample as well.

Cross-sectional differences among funds can also lead to differences in outcomes (Chevalier and Ellison, 1999; Chen et al., 2004; Berk and Green, 2004). Funds of different ages or sizes may be inherently more or less fragile as their ability to withstand market shocks may be different. To mitigate these concerns, we include fund age quintile $\times$ quarter fixed effects and fund size quintile $\times$ quarter fixed effects as controls. These fixed effects flexibly absorb time-variant differences in fund outcomes by age and size.

To study the effectiveness of the Liquidity Rule appropriately, we need to compare mutual fund outcomes during periods of significant market turmoil. The COVID-19 crisis of 2020–2021 occurred almost immediately after the Liquidity Rule, providing a test of the rule during a crisis period. However, a comparable event did not happen in the years immediately preceding the

Liquidity Rule. For this reason, we follow an approach similar to that of Li et al. (2021) and identify the Financial Crisis of 2008–2009 as our pre-rule period in our main analyses. Additionally, we also check if funds responded to the Liquidity Rule and raised their liquidity levels. In this specific test, we use the immediate pre-rule period (2014–2015).

2.3 Data Sources & Summary Statistics

We implement our difference-in-differences analysis using data from Morningstar Direct at the fund share class-quarter level. The data set includes all available quarterly performance, holdings, and classification data for open-end mutual funds domiciled in either the United States or Canada for the time periods of interest. As in Goldstein et al. (2017), our unit of observation is fund-share class-quarter. This is because each class of the fund has its own expense ratio, performance measurement, and flow calculation. To account for overlapping fund-level decisions by fund management, we use fund-fixed effects in our specifications, wherever appropriate. In addition, to classify funds into fixed income funds in the Morningstar Direct dataset, we select all funds that have more than 15% of their assets in bonds and are not classified in an equity fund category in Morningstar Direct.

Our first variable of interest is the percentage of the aggregate fund portfolio that is invested in highly liquid securities, which we define as cash, government securities, and repurchase agreements (*Liquid Holdings %*). Second, we study fund flow (*Fund Flow*) which is calculated after adjusting for the return over the last period. The next variable of interest is fund exits (*Fund Exits*), which is an indicator variable set to one if the fund exits Morningstar Direct in the next calendar quarter and zero otherwise.

In all our analyses, we include control variables commonly used in the literature: fund age (*Fund Age*), fund size (*Fund Size*), the fund's performance (*Fund Performance*), and the fund's expense ratio (*Expense Ratio*). *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the

natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points.[11] *Fund Performance* is the 12-month rolling Morningstar alpha. For fixed income subsamples, we calculate α_{gjn}, which is the fund performance measure in Goldstein et al. (2017). The performance measure calculates the 12-month alpha using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund return.

We obtain data for these variables for the calendar years 2008–2009 and 2020–2021 to compare the two crises, resulting in a sample that includes 9,124 total funds (3,264 bond funds) with 40,578 fund classes (15,104 bond fund classes). We also obtain data for the calendar years 2014–2015 when studying whether the rule had the intended consequence of increasing fund-level liquidity (Section 3.1) around its adoption.

We present descriptive statistics for our sample of U.S. and Canadian open-end mutual funds in Table 1. Panel A displays summary statistics for all mutual funds for the years 2020–2021 & 2014–2015. This sample includes a total of 328,823 fund share-class-quarter observations, just over half of which are for U.S.-domiciled funds (56.6%). The average amount of highly liquid holdings is about 12.42% of a fund's portfolio, with a median of about 5.2%. The median fund age (*Fund Age*) is approximately 7 years. The average expense ratio of a fund is about 1.24%, consistent with prevailing expense ratios. Finally, the average fund performance is -0.33 pp. (-0.24 pp. median), consistent with numerous previous studies concluding that mutual funds underperform the broader market (e.g., Wermers, 2000). Panel B displays the subsample of fixed income funds. These values are comparable to those in Panel A, with the only difference being that fixed-income funds have a slightly higher amount of highly liquid holdings.

We report the same statistics in Panels C and D, now for the years 2020–2021 & 2008–2009, namely the sample period we use for most of our analyses, for all mutual funds and fixed income

[11] For Canadian funds we use management expense ratios (MER), as these are the available expense ratios in Morningstar Direct.

mutual funds, respectively. The moments reported in these two panels remain similar to the first two panels.

In Table 2, we further disaggregate and report descriptive statistics for our fixed income mutual funds sample for the years 2020–2021 & 2008–2009 separately for U.S. funds (Panel A) and Canadian funds (Panel B). We observe that U.S. funds are older and larger, experience larger flows, and perform better compared to Canadian funds. Finally, we partition our sample of U.S. fixed income mutual funds for the years 2020–2021 & 2008–2009 into High Yield (Panel C) and non-High Yield (Panel D). Consistent with economic intuition, High Yield funds hold fewer liquid holdings, have a higher likelihood of exit, and also display higher performance, albeit with a larger standard deviation.

3 Effects of the Rule on Liquidity and Fragility of Funds

We start by establishing the relevance of the Liquidity Rule in Section 3.1. Given that the main purpose of the rule was to reduce fund fragility, Section 3.2 explores whether run incentives for U.S. bond fund investors decreased post-rule. Section 3.3 examines how fund exits have evolved post-rule given the change in investor run incentives. In Section 3.4, we consider the effects of the sale of illiquid securities on fund NAV. We investigate how funds manage liquid and illiquid holdings in response to the liquidity rule during crises in Section 4.

3.1 The Effect of the Rule on the Level of Liquid Holdings of U.S. Funds

The Liquidity Rule requires funds to hold a sufficient amount of liquid assets as a buffer against potential redemption shocks. The rule formally required funds' boards of directors to establish, and fund managers to maintain, a minimum level of highly liquid holdings. In this section, we investigate whether these mandatory requirements had the intended effect of inducing funds to increase the overall liquidity of their holdings. The null hypothesis is that the rule did not change

the investment decisions of the funds.

We test the effect of the rule on fund liquidity levels by estimating the following equation:

$$Y_{i,t} = \beta_1 \cdot \text{U.S.}_i \times \text{Post}_t + \sum_j \gamma_j \cdot \text{Fund level controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \varepsilon_{i,t}, \quad (1)$$

for fund i and quarter t. Y is our measure of funds' highly liquid holdings (*Liquid Holdings %*), defined as the sum of cash holdings, government securities, and repurchase agreements reported by Morningstar for the quarter. *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus affected by the rule, and zero if it is domiciled in Canada and therefore unaffected by the rule. *Post* splits the sample into pre- and post-adoption periods. The indicator equals one if the fund-quarter observation occurs in the years 2020–2021, and zero otherwise. As discussed in Section 2.2, the pre-period is the two years just before regulatory actions related to the Liquidity Rule (2014–2015) or during the Financial Crisis (2008–2009). Fund controls include age, size, expense ratio, and performance. As we use fund share-quarter observations, we include fund identifier and quarter-year fixed effects for all specifications. Additionally, we include fund size quintile and fund age quintile both interacted with quarter-year fixed effects, where noted. We cluster standard errors by fund share class.[12]

Table 3, column (1) reports the results of this estimation on the sample of all funds in the U.S. and Canada. We find that after the implementation of the Liquidity Rule, U.S. funds on average hold 6 pp. more highly liquid securities as a fraction of their assets compared to Canadian funds. Even though column (1) includes fund and quarter fixed effects, it is possible that there is

[12]Our identification strategy utilizes a pre- and post-rule change period, where the post-sample and the pre-sample are only eight quarters each. Under these conditions, clustering by time can raise the concern of over-rejection of the null in the panel difference in differences setting (Angrist and Pischke, 2009; Cameron and Miller, 2015). Hence, we do not cluster by quarter to avoid unreliable inferences. Nevertheless, to address concerns that residual errors can be correlated in the same time period, we focus on the source of such correlations (Chevalier and Ellison, 1999; Chen et al., 2004; Berk and Green, 2004). After controlling for fund size quintile $\times$ time and fund age quintile $\times$ time, we confirm that in our specifications, correlation among residuals is less than 0.02. Petersen (2008) discusses a correlation among residuals of less than 0.12 as "small." Our approach is similar to Goldstein et al. (2017) who also cluster by fund share class.

significant time-variant heterogeneity in fund holdings of highly liquid securities. For example, smaller and younger funds may hold more liquid assets in certain periods because such funds are more vulnerable to redemption risks (Chevalier and Ellison, 1997). Column (2) therefore includes fund-age-quintile×quarter-year and size-quintile×quarter-year fixed effects. The results remain equivalent, suggesting that higher cash holdings cannot be explained away by the holding patterns of smaller or younger funds in certain time periods.

As fixed income funds are the focus of the Liquidity Rule and, therefore, our analysis, column (3) restricts the estimation sample to all fixed income funds in the U.S. and Canada. Fixed income funds are also more likely to face liquidity mismatch and therefore must carefully manage their liquidity. The coefficient estimates in column (3) indicate that the liquid holdings of U.S. fixed income funds are 7.7 pp. higher than those of Canadian fixed income funds in the post-Liquidity Rule period.

Figure 1 reports the point estimates of marginal liquidity held by U.S. funds by quarter. The figure shows that there is no discernible pre-trend in liquid holdings of U.S. funds compared to Canadian funds before the Liquidity Rule was implemented. The pre-period in the regressions (1)–(3) and the figure is the time period of 2014–2015 when the rule was not anticipated.[13] After the implementation of the rule, the figure shows that liquid holdings of U.S. funds are higher compared to those of Canadian funds.

The post-rule period overlaps with the COVID-19 crisis. The presence of additional liquidity buffers in U.S. funds can help reduce run incentives of investors. Reducing run incentives through additional liquid holdings might have been one of the intended outcomes of the regulators. However, even during the COVID-19 crisis, the additional liquidity for U.S. funds in Figure 1 is mostly unresponsive to the crisis. This observation provides preliminary evidence that U.S. funds do not seem to expend their additional liquidity buffers even during periods of increased redemptions. On

[13] As discussed in Section 2.1, the Liquidity Rule was proposed and adopted in 2016. Funds were required to comply by June 2019.

its own, the presence of this additional liquidity in the U.S. does not necessarily imply a reduction in systemic stress. Nor is it the case that the lack of use of this additional liquidity is in itself a problem: U.S. funds may be selling an equal fraction of all assets during crises, which can mean less reliance on liquid holdings to meet redemptions.

To further understand fund behavior during crises, we modify our analysis by redefining the pre-period to overlap with the Financial Crisis of 2008–2009. This change in the pre-rule period data sample allows us to compare the liquidity holdings of U.S. and Canadian funds during market stress under the two regulatory regimes. Our estimation results are reported in columns (4)–(6).

As in columns (1)–(3), the point estimate in column (4) shows that the difference in liquidity holdings between U.S. funds and Canadian funds is 10.5 pp. higher during the COVID-19 liquidity crisis relative to the difference during the 2008–2009 Financial Crisis. This observation suggests that, even in a cross-crises comparison, U.S. funds held more liquidity post-rule. Column (5) shows that these results are robust to the inclusion of fund size and age quintile interactions with year-quarters. This robustness of the result indicates that higher liquidity holdings are not restricted to small or young funds facing differential market conditions. The sample of fixed-income mutual funds also delivers similar results, as shown in column (6), where U.S. fixed income funds held 6.5 pp. greater highly liquid securities.

Figure 2 displays the point estimates of the difference in liquidity holding between U.S. and Canadian funds by quarter during the two crises. During the Financial Crisis, U.S. funds do not appear to hold more liquid holdings relative to Canadian funds. In terms of responsiveness, we note that U.S. funds reduced liquidity faster than Canadian funds during the 2008 Financial Crisis. The average liquidity of U.S. funds was the lowest compared to Canadian funds at the height of the crisis. This is intuitive because the Financial Crisis emanated from the U.S. fixed income complex, and hence U.S. funds faced more redemption pressure compared to Canadian funds. Such a response suggests that funds used their capital buffers in a countercyclical manner as is appropriate to alleviate systemic risk (similar to the findings in Choi et al., 2020, regarding the

2008 crisis).

However, after the rule, the liquid holdings of U.S. funds are higher than those of Canadian funds. Moreover, even though U.S. funds held a higher level of highly liquid holdings post-rule, they did not use these holdings more aggressively than Canadian funds in response to redemption pressures during the COVID crisis. This behavior stands in contrast to the pre-rule response of U.S. funds to the previous crisis.

The above analysis, while suggestive, provides a limited picture of the impact of the rule on fund-level liquidity. In Section 4, we use holdings-level data to find out which assets are actually sold by funds. However, before we conduct holdings-level analysis, the following subsections investigate the effect of the rule on fund fragility.

3.2 Flow Performance Sensitivity of U.S. Funds after the Rule

The previous section compared the average liquidity levels of funds across time periods. The results suggest that U.S. funds maintained additional liquid holdings post-rule. This behavior may be the intended outcome of the Liquidity Rule: to reduce run incentives by requiring funds to have more liquidity buffers.

Hence, this section investigates whether run incentives for investors indeed decrease post-rule. For this analysis, we leverage the seminal work on bond fund fragility by Goldstein et al. (2017), who establish that bond fund outflows are highly sensitive to recent underperformance. Following their framework, we estimate the change in sensitivity of outflows to fund performance around the rule:

$$\begin{aligned}\text{Fund Flow}_{i,t} =& \beta_1 \cdot \text{U.S.}_i \times \text{Post}_t \times \text{Lagged } \alpha_{\text{gjn } i,t} + \sum_{j=2} \beta_j \cdot \text{Lower order interaction terms}_{i,t} \\ &+ \sum_j \gamma_j \cdot \text{Controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \varepsilon_{i,t}, \end{aligned} \tag{2}$$

for fund i and quarter t. *Fund Flow*$_{i,t}$ is calculated after adjusting for the return over the last period.

α_{gjn} is the rolling one-year alpha, where alpha is calculated using benchmark returns from both the CRSP Total Market Index and the Vanguard Total Bond Market Index. Thus, this is a fixed income specific alpha which we use in all analyses here onward. Following the framework of Goldstein et al. (2017), for quarter t, we measure fund flow during the last month of the quarter and calculate the trailing 12-month alpha ending just before that month begins.

As before, *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus treated by the rule, and zero if it is domiciled in Canada and therefore not affected by the rule. *Post* splits the sample into pre- and post-adoption periods. As market fragility often occurs during crises, we focus on bond funds during the financial crisis and the COVID crisis (similar to Li et al., 2021). The indicator equals one if the fund-quarter observation occurs in the years 2020–2021, and zero for the Financial Crisis years (2008–2009).

Fund controls include age, size, and expense ratio. As we use fund share-quarter observations, we include fund and quarter-year fixed effects for all specifications. Additionally, we include fund size quintile and fund age quintile, each interacted with quarter-year fixed effects, where noted. We cluster standard errors by fund share-class.

The variable of interest is the triple interaction term $U.S. \times Post \times \alpha_{\text{gjn}}$. The corresponding coefficient β_1 represents the marginal sensitivity of U.S. bond fund flows to performance post-rule. If the Liquidity Rule helps reduce run incentives—in this case, outflows following fund underperformance—then we should find that fund flows are less sensitive to fund underperformance after the rule. In other words, given fund underperformance, i.e., fund $\alpha < 0$, an estimate of $\beta_1 < 0$ would suggest a reduction in fragility (i.e., less sensitive to performance). In contrast, an estimate of $\beta_1 = 0$ would suggest that the Liquidity Rule did not reduce bond fund fragility. Further, a positive value of β_1 suggests an increase in fund outflows conditional on underperformance.

We start with Figure 3 that reports the triple interaction coefficient estimates by performance quintile. The figure shows that U.S. bond funds in the bottom two quintiles of performance exhibit higher fund outflows after the rule. Approximately three percentage points higher outflows take

place for U.S. funds in the post-rule period compared to the benchmark of Canadian bond funds.

Table 4 performs a more careful investigation of change in fund flow performance conditional on the Liquidity Rule. The point estimate of the triple interaction coefficient in column (1) suggests that after the Liquidity Rule was implemented, one standard deviation underperformance (0.52 pp from Panel D of Table 1) leads to 0.54 pp higher outflows in U.S. bond funds (the calculation is $0.52 \times 1.044 = 0.54$). Section 2.1 discusses that there does not appear to be a specific regulation in Canada that can confound our estimates. Nevertheless, a concern may be that the results are driven by changes in Canada. Hence, columns (2) and (3) split the sample by countries. The point estimate in the U.S., as reported in column (2), remains statistically similar to that in column (1).

Column (3) shows that bond fund flow sensitivity in Canada to fund performance pre-rule and post-rule remains similar. Note that Canada in general has a high level of performance-to-flow sensitivity. This is consistent with prior literature that investigates the heterogeneity in fund performance and flows across countries (Ferreira et al., 2013).

In columns (4)–(6), we subsample the data further by fund performance. The purpose is to focus on bond funds with negative performance since such funds face larger fragility concerns (Goldstein et al., 2017). We bifurcate α_{gjn} at zero, separating it into two different variables for negative and positive performance, i.e., Neg. α_{gjn} and Pos. α_{gjn}, respectively. The triple interaction point estimate of column (4) is economically significant for bond funds with negative performance. After the implementation of the Liquidity Rule, one standard deviation underperformance (0.52 pp.) leads to 1.03 pp. higher outflows in U.S. bond funds (the calculation is $0.52 \times 1.9861 = 1.03$). Column (5) shows that these results obtain within the subsample of U.S. funds. Column (6) again shows that Canadian funds do not exhibit an incremental increase in sensitivity to underperformance in crisis periods.

In sum, U.S. funds did not experience a reduction in fund flow sensitivity conditional on underperformance. Instead, the results suggest that U.S. bond funds that underperformed post-rule suffered from higher outflows. Thus, fund fragility as measured by fund flow sensitivity increased

in the U.S. after the rule. These findings are not present in Canada, which does not have a similar liquidity rule.

3.3 The Effect of the Rule on U.S. Fund Exits

Section 3.2 shows that after the Liquidity Rule, investor run incentives increased, rather than decreased. Given higher run incentives, in this section, we pursue the next logical question: Do U.S. funds exit more often after the Liquidity Rule?

Table 5 uses a similar specification as in previous sections. The outcome variable in this case is whether the fund exits the panel (zero if it does not, one if it does in the last period). As before, the sample consists of all funds for the periods of the Financial Crisis (2008–2009) before the Liquidity Rule and the COVID-19 crisis years (2020–2021) after the Liquidity Rule, which are the two episodes of high market stress.

Column (1) reports that after the rule, U.S. fixed income funds exit 1.2 pp. more often than Canadian funds. These results are more than four times stronger when we focus solely on U.S. high-yield bond funds in column (2). The illiquidity of high yield bonds makes high yield bond funds particularly susceptible to fragility concerns. Column (2) utilizes all fixed income funds in U.S. and Canada as the control group.

To ensure that the results are not due to the inclusion of Canadian funds that may have become safer, columns (3) and (4) split the sample by country. Column (3) continues to show similar results as column (2); a 5.37 pp. higher rate of fund exit for U.S. high-yield funds post Liquidity Rule during the COVID crisis period, compared to the pre-rule financial crisis period. Column (4) reports no discernible change in fund exit rates for Canadian high-yield funds compared to other Canadian funds. We further present a direct comparison of U.S. and Canadian high-yield bond funds in column (5), and continue to find that U.S. high-yield funds exit more frequently post-rule.

Column (6) sums up the results with a triple interaction of *Post* $\times$ *HY Fund* $\times$ *U.S.* The point estimate of *Post* $\times$ *U.S.* informs us that, on average, U.S. funds exit more frequently post-rule, as

expected from our findings in column (3). The point estimate of *Post* $\times$ *HY Fund* suggests that there was no systematic increase in the exits of high-yield funds across the two countries. However, the triple interaction coefficient estimate shows that U.S. high-yield funds exit more post-rule.

Thus, our results show that after the Liquidity Rule—notwithstanding higher liquidity buffers—U.S. fund flow sensitivity increased conditional on underperformance and U.S. funds exit more frequently. These results are consistent with the findings in Zeng (2017) that runs can occur even if funds have high liquidity.

3.4 The Effect of the Rule on U.S. Fund Performance

So far, Section 3.1 establishes that U.S. funds hold more liquidity post-rule. However, this additional liquidity does not reduce run incentives of investors. Empirical tests in Sections 3.2 show that funds that underperform post-rule face larger outflows in a crisis. Further, U.S. bond funds, especially those with illiquid securities, exit more often post-rule (Section 3.3).

To complete the investigation of the vicious feedback loop that often takes place during a market crisis, we next investigate the effects of the sale of highly illiquid securities on fund performance. It is possible that the presence of additional funding liquidity allows funds to provide market liquidity (Brunnermeier and Pedersen, 2008), and collectively funds avoid underperformance. However, additional liquidity does not guarantee that funds will not face a run (Zeng, 2017). Zeng (2017) shows that if fund managers face a liquidity mismatch during a crisis and sell more illiquid securities to rebuild the cash buffer, then the fund can face shareholder runs.[14]

We conduct a detailed analysis of the holdings sold by funds during a crisis in Section 4. At the same time, to set up the rest of the table, column (1) of Table 6 examines whether U.S. funds sell more illiquid securities post-rule. For this analysis, as for the analysis in Section 4, we identify

[14]Chen et al. (2010); Goldstein et al. (2017); Shek et al. (2017) empirically document this mechanism in general. Zeng (2017) also shows that if fund managers deplete liquid securities to meet redemptions, this action may trigger a run on the fund. Zeng (2017) points out that *"Runs can occur in equilibrium regardless of whether the fund starts with a high cash position or a low one. However, the nature of strategic interactions among shareholders differs between these two cases."*

each holding of each fixed income fund in the U.S. and Canada. We then calculate the liquidity of each individual security as described in Appendix B. Securities in the bottom two quintiles gain a classification of "most illiquid" securities (holdings-level analysis in Section 4.2 and Figure 4 further justify this classification). Finally, we identify funds that sell significant illiquid holdings in a quarter. The binary variable *Large Sale of Illiquids* is equal to one if a fund-quarter is in the 95th percentile of observations in terms of the intensity of sale of illiquid securities (*Sale of Illiquid Holdings)*, and zero otherwise.

Column (1) in Table 6 shows that funds sell more illiquid holdings in the U.S. post-rule. Figure 4 confirms the findings in column (1) that indeed U.S. funds are selling more illiquid assets post-rule. Figure 5 shows this shift is within the U.S.: Canadian funds do not change their behavior over time. If anything, there is a statistically insignificant increase in the probability of the sale of liquid securities in Canada (right panel of Figure 5).

As discussed above, the observation that U.S. funds sell more illiquid holdings post-rule on its own does not necessarily suggest that funds are worse off through such sales. Column (2) investigates if the performance of U.S. funds suffers when they sell more illiquid securities. The point estimate of the triple interaction term in the column suggests that funds that sell one standard deviation (0.0429) more illiquid securities have 0.70 pp. lower return (the calculation is $0.0429 \times -0.1624 = -0.0070$). This reduction in return is of the same order of magnitude as one standard deviation of the return of fixed income funds in the sample. Focusing on the sample of U.S. fixed income funds in column (3), we find that the reduction in returns is 0.23 pp. ($-0.0532 \times 0.0429 = -0.0023$).

Column (4) shows that Canadian funds do not suffer from fund underperformance when they sell illiquid assets. This result suggests that selling illiquid assets *per se* may not be the problem. As Zeng (2017) notes, "cash-rebuilding implies predictable voluntary sales of illiquid assets and hence a predictable decline in NAV. This generates a first-mover advantage, leading to shareholder runs." In the presence of the Liquidity Rule in the U.S., funds are required to make predictable

sales to rebuild the cash buffer. In Canada, without the Liquidity Rule, sales of illiquid assets, when they happen, are not as predictable and hence do not lead to declines in Net Asset Value (NAV) and investor runs. Figure 5 shows that Canada did not increase the sale of illiquid securities and does not suffer from underperformance due to the sale of illiquid assets.

In Column (5)–(7), we repeat this analysis using a binary outcome variable of fund underperformance. Column (5) reports that U.S. funds that sell one standard deviation more illiquid securities have 31 pp. higher probability of underperformance post-rule ($0.0429 \times 7.1532 = 0.3069$). Column (6) focuses on the U.S. subsample and finds a 20 pp. increase in the probability of underperformance ($0.0429 \times 4.5439 = 0.1949$). Canadian funds in column (7) show no statistical increase in underperformance due to the sale of illiquid securities.

In sum, the results in Section 3 suggest that (i) conditional on underperformance, fund outflows increase in the U.S. post-rule during COVID (Section 3.2) and (ii) there are more fund closures (Section 3.3); (iii) U.S. funds have a higher likelihood of selling illiquid securities post-rule (Section 3.4 and more results in Section 4); (iv) such sale of illiquid securities increases fund underperformance (Section 3.4). The findings (i)–(iv) point towards the vicious cycle of market fragility: underperformance increases flows; and as funds sell more illiquid securities, such sales increase underperformance.

4 Fund Holdings Response to the Rule

To complement the fund-level analysis in the previous section, this section analyzes the effect of the Liquidity Rule on fund holdings. Section 4.1 estimates how funds manage very liquid holdings conditional on outflows. Section 4.2 explores how funds manage less liquid assets around the rule.

4.1 Management of Liquid Holdings Around the Rule

A preliminary result in Section 3.1 was about the sensitivity of liquidity of U.S. funds. We noted that the level of liquidity of U.S. funds did not exhibit significant changes post-rule during the COVID-19 crisis. This is different from the changes in liquidity levels in U.S. funds pre-rule during the financial crisis. As we noted in that section, additional investigation is necessary to understand how U.S. bond funds manage liquidity during a crisis.

In this section, we examine whether U.S. funds differentially used (i.e., reduced) their elevated levels of highly liquid holdings in response to outflows post rule. We allow for heterogeneous responses across funds by utilizing three measures of fund outflows. Thus, the specification estimates the use of highly liquid holdings in response to fund outflows:

$$\begin{aligned}\text{Liquid Holdings } (\%)_{i,t} =& \beta_1 \cdot \text{U.S.}_i \cdot \text{Post}_t \cdot \text{Outflow Measure}_i + \sum_{j=2} \beta_j \cdot \text{Lower order interaction terms}_{i,t} \\ &+ \sum_j \gamma_j \cdot \text{Controls}_{i,t} + \text{Fund Chars.}_{i,t} \cdot \eta_t + \zeta_i + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

where the dependent variable is the fund's highly liquid holdings.[15] The three outflow measures are: i) *Outflow*, which is a continuous measurement of fund outflows; ii) *Outflow (Top Decile)*, which is equal to one if the fund's outflows are in the top decile of all funds for that year, and zero otherwise; and iii) *Outflow (US/CA Top Decile)*, which is equal to one if the fund's outflows are in the top decile for that year of either all U.S. funds or all Canadian funds conditional on where the fund is domiciled, and zero otherwise. We collect fund flows data from Morningstar. To convert net flows into outflows, we multiply the quarterly net flows data by negative one and bound the

[15] As before, treatment variable *U.S.* splits our sample into funds domiciled in the U.S. and funds domiciled in Canada. *Post* splits the sample into pre- and post-adoption periods, with the pre-period represented by the Financial Crisis years (2008–2009). The indicator equals one if the fund–quarter observation occurs in the years 2020–2021, and zero otherwise. We adopt the same battery of controls as in previous tables. As before, we use fund share-quarter observations, we include fund fixed effects for all specifications, and additionally include fund size quintile and fund age quintile each interacted with quarter-year fixed effects where noted, and cluster standard errors by fund share-class. Controls include fund age, size and expense ratio.

variable at zero (i.e., inflows are represented as zero). This approach eases the interpretation of our results.

Table 7 reports the results. The estimated coefficients of the term *U.S.* $\times$ *Outflow* are negative and statistically different from zero in columns (1) and (2). Column (1) considers a continuous measure and column (2) utilizes a discrete measure for funds facing top decile outflows. These results suggest that on average, U.S. funds respond to outflows induced by aggregate liquidity shocks by reducing their liquid holdings more aggressively than Canadian funds. The triple interaction coefficients (*U.S.* $\times$ *Post* $\times$ *Outflow*) are positive and statistically different from zero. These point estimates suggest that the sensitivity of liquid holdings to outflows has declined after the enactment of the Liquidity Rule in the United States. Overall, we find that U.S. funds, even those facing significant outflows, do not use their highly liquid securities in response to redemption requests from investors.

To further understand the total change in the level of liquidity of U.S. bond funds in the post-rule period, we use estimates in column (2) where we focus on funds with top decile outflows and conduct a linear combination of estimates test:

$$\beta[\text{U.S.} \times \text{Post}] + \beta[\text{U.S.} \times \text{Outflow (Top Decile)}] + \beta[\text{U.S.} \times \text{Post} \times \text{Outflow (Top Decile)}] = 0,$$

where $\beta[x]$ represents the point estimate associated with the term x. The total effect in this case remains significantly positive—even for funds with top decile outflows—at 7.40 pp. (p-value $<$ 0.01). Thus, even the U.S. funds that face significant outflows in the post period maintain higher liquid assets. The point estimates also shed light on why we observe an almost flat liquidity level in Figure 2 during the COVID-19 crisis, even during the first two quarters of 2020: the sensitivity of liquidity holdings to outflows for U.S. mutual funds is almost zero in the post-adoption period. These findings point towards the possibility that post-rule, U.S. fund managers facing liquidity mismatch during a crisis maintain high liquidity levels.

In columns (3) and (4), we repeat the analysis separately by country.[16] The point estimate of the interaction term *Post* × *Outflow* in column (3) shows that U.S. funds maintain higher liquidity even in the presence of significant outflow post-rule, while Canadian funds do not exhibit a difference in response over time in column (4).

Column (5) repeats the analysis in column (2) but defines funds that experience significant outflows as funds in the top decile of the country-specific sample outflow distribution. We observe that U.S. funds decrease their liquid holdings to meet redemption during market-wide liquidity crises by 5.14 pp. in the pre-rule period. Following the adoption of the Liquidity Rule, however, their sensitivity to significant outflows declines, as indicated by the 4.43 pp. marginal effect estimated from the triple interaction term.

In sum, before the rule, U.S. funds reduced liquid holdings during market stress. This was also the period when Choi et al. (2020) shows that U.S. corporate bond funds were able to absorb investor redemption risk without excessively liquidating corporate bonds. In the post-Liquidity Rule period, however, U.S. bond mutual funds maintained higher levels of liquidity.

The outcomes observed may be because fund managers want to preserve liquidity buffers. At the same time, if relatively higher sales of illiquid securities take place, then that can also lead to runs because shareholders' run decisions can exhibit strategic complementarity when fund managers sell illiquid assets to cover redemptions (Zeng, 2017). We investigate whether more illiquid securities are indeed sold post-rule in the next section.

4.2 Management of Less Liquid Holdings around the Rule

We began Section 3.4 with a test regarding whether U.S. funds sell more illiquid securities post-rule. In this section, we follow up with a more in-depth analysis regarding which holdings funds sell during a crisis. Section 4.1 above shows that U.S. funds sell fewer highly liquid assets

[16] We note that the average higher level of liquidity maintained post-rule by U.S. funds is absorbed by time fixed effects in these analyses.

post-rule. Hence, in this section, we focus on the management of less liquid holdings, specifically, municipal and corporate bonds.[17] We collect all available data on holdings of every fixed income fund in the U.S. and Canada and measure the liquidity of each individual bond as described in detail in Appendix B.

We divide the financial instruments into five quintiles, where rising quintile numbers represent higher liquidity. In other words, quintile one is the least liquid and quintile five has the most liquid bonds. Column (1) in Table 8 conducts an instrument-level analysis. The variable of interest is the triple interaction term *U.S.*$\times$ *Post* $\times$ *Liquidity quintile*. The point estimate of the coefficient suggests that post-rule, U.S. funds have a lower likelihood of selling more liquid corporate and municipal bonds. Column (2) includes interactions of fund size and fund age quintiles with quarter fixed effects. The similarity of the point estimate for the triple interaction term suggests that the results are not due to the behavior of smaller and younger funds.

Figure 4 utilizes the same specification as that in the regressions. In addition, the figure displays the triple interaction effect by liquidity quintile. The figure shows that the least two liquid quintiles held by U.S. funds experience an increase in the likelihood of sales post-rule. Figure 5 divides the sample by country. It reports the change in sale likelihood of holdings in the U.S. and Canada by security-level liquidity quintiles after the Liquidity Rule. The left panel of Figure 5 shows that the dynamics observed in Figure 4 are also present within the United States. The right panel of the same figure indicates a statistically insignificant change over time for Canada. If anything, Canadian funds sell more liquid securities over time, suggesting that the U.S. pattern is different from the Canadian sale pattern.

These observations from the figure are also supported by the regressions in columns (3) and (4), where we split the sample by country. Within the sample of U.S. funds, column (3) finds that

[17] Researchers have paid specific attention to these two bond markets. Goldstein et al. (2017); Falato et al. (2021), among others, have investigated financial fragility concerns in the corporate bond funds. Recently, Li et al. (2024) study how the interactions of mutual funds and dealers introduce fragility to the municipal bond market and induce lasting market impacts.

post-rule, as the liquidity of a bond increases, its likelihood of getting sold decreases. No such result exists in the Canadian sample.

In sum, we show that after the introduction of the Liquidity Rule, funds indeed sell more illiquid securities (this section) and preserve liquidity (Section 4.1). At the same time, as shown in the successive sections of Section 3, fund outflows increase due to underperformance, fund exits also increase, and higher outflows lead to further fund underperformance. Thus, we empirically corroborate a key finding of Zeng (2017): that additional liquidity alone does not guarantee that funds will not face a run.

5 Conclusion

Open-end funds that hold illiquid assets have grown over time. Similar to banks, these funds face liquidity mismatch concerns. After the collapse of Third Avenue Focused Credit fund, the SEC adopted Rule 22e-4 to help reduce fund fragility. We find that post-regulation, affected funds increase their highly liquid holdings, as intended by the SEC. However, we do not find that affected funds are able to utilize their increased liquid holdings to reduce fund fragility during the COVID crisis.

Our results suggest that the regulatory intervention exacerbated systemic liquidity risk: conditional on past underperformance, bond fund flows increase in the U.S. post-rule during COVID. Further, we document more bond fund closures post-rule. Also, funds have a higher likelihood of selling illiquid securities post-rule, and such sales of illiquid securities increase underperformance. The findings point towards the vicious cycle of bond fund fragility: underperformance increases flows; and as funds sell more illiquid securities, such sales increase underperformance. These results are in line with the findings in Zeng (2017), who notes that fund runs can occur regardless of whether fund liquidity levels are high or low.

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Figure 1: The Effects of the Liquidity Rule on Highly Liquid Holdings of U.S. Funds

This figure plots the difference-in-differences coefficient estimates by quarter for highly liquid securities held by U.S. funds compared to Canadian funds around the implementation of the Liquidity Rule. The pre-period is 2014–2015 and post-period is 2020–2021, after the Liquidity Rule's adoption. The regression equation is as follows:

$$Y_{i,t} = \beta_t \cdot \text{U.S.}_i \times \text{Quarter}_t + \sum_j \gamma_j \cdot \text{Fund level controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \varepsilon_{i,t},$$

for fund i and quarter t. Y measures funds' highly liquid holdings (*Liquid Holdings %*), defined as the sum of cash holdings, government securities, and repurchase agreements reported by Morningstar for the quarter. *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus affected by the rule, and zero if it is domiciled in Canada and therefore unaffected by the rule. *Quarter* is an indicator variable that switches to one for a specific quarter of a year in the pre- and post-adoption periods (2014–2015 and 2020–2021, respectively). Fund controls include size, age, expense ratio and performance. As we use fund share-quarter observations, we include fund fixed effects, and additionally include fund size quintile and fund age quintile each interacted with quarter-year fixed effects. We cluster standard errors by fund share class.

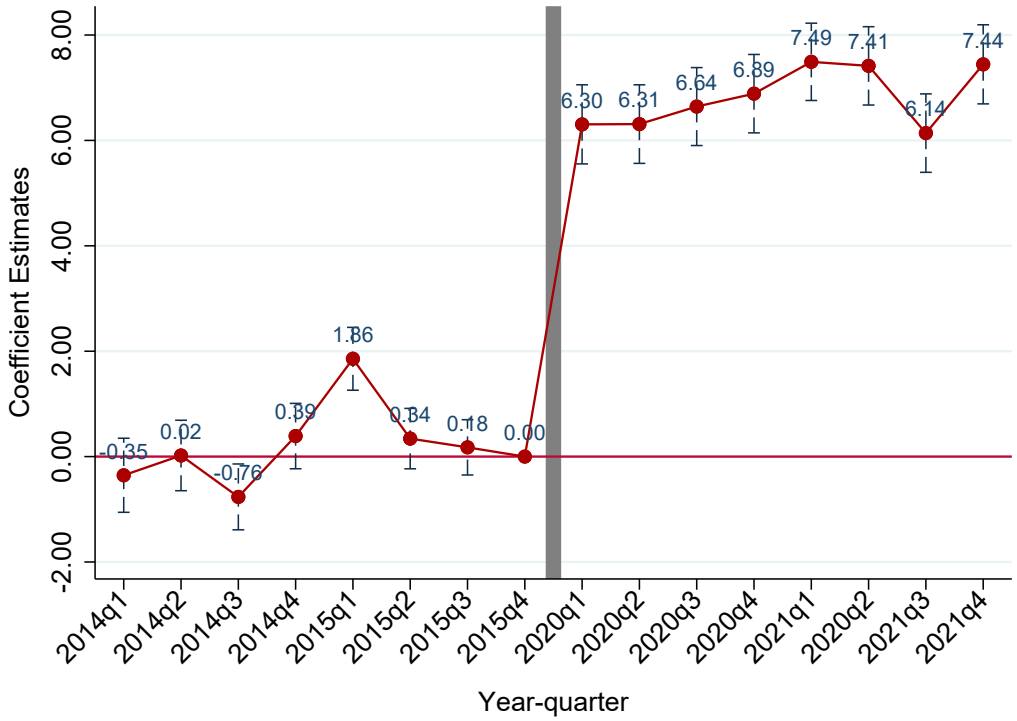

Figure 2: Highly Liquid Holdings of U.S. Funds During the Financial and COVID Crises

This figure plots the difference-in-differences coefficient estimates by quarter for highly liquid securities held by U.S. funds compared to Canadian funds, analyzing the effects of the Liquidity Rule on holdings during crisis periods. The pre-period is during the Financial Crisis 2008–2009 and post-period is during the COVID-19 crisis 2020–2021, after the Liquidity Rule's adoption. The regression equation is as follows:

$$Y_{i,t} = \beta_t \cdot \text{U.S.}_i \times \text{Quarter}_t + \sum_j \gamma_j \cdot \text{Fund level controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \varepsilon_{i,t},$$

for fund i and quarter t. Y is our measure of funds' highly liquid holdings (*Liquid Holdings %*), defined as the sum of cash holdings, government securities, and repurchase agreements reported by Morningstar for the quarter. *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus affected by the rule, and zero if it is domiciled in Canada and therefore not affected by the rule. *Quarter* is an indicator variable that switches to one for a specific quarter of a year in the pre- and post-adoption periods (2008–2009 and 2020–2021, respectively). Fund controls include size, age, expense ratio and performance. As we use fund share-quarter observations, we include fund fixed effects, and additionally include fund size quintile and fund age quintile each interacted with quarter-year fixed effects. We cluster standard errors by fund share class.

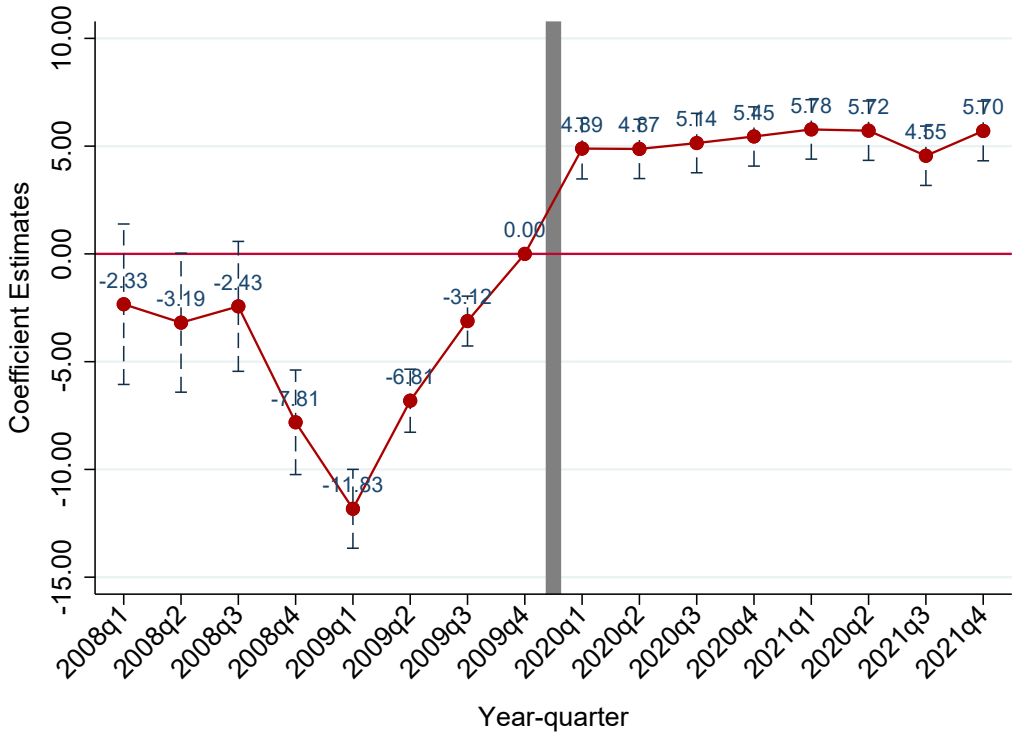

Figure 3: Change in Flow Performance Sensitivity During COVID-19 Crisis in U.S. Post Rule

This figure estimates the fund flow sensitivity in the U.S. post-rule conditional on performance by quintiles. The comparison group is fixed income funds in Canada. The specification is as follows:

$$\text{Fund Flow}_{i,t} = \vec{\beta}_1 \cdot \text{U.S.}_i \times \text{Post}_t \times \text{Lagged } \alpha_{\text{gjn } i,t} + \sum_{j=2} \beta_j \cdot \text{Lower order interaction terms}_{i,t} + \sum_j \gamma_j \cdot \text{Controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \varepsilon_{i,t},$$

for fund i and quarter t. $\vec{\beta}_1$ represents a vector of coefficients, corresponding to performance quintiles. *Fund Flow*$_{i,t}$ is calculated after adjusting for the return over the last period. α_{gjn} is the rolling one-year alpha, where alpha is calculated using benchmark returns from both the CRSP Total Market Index and the Vanguard Total Bond Market Index. *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus affected by the rule, and zero if it is domiciled in Canada and therefore unaffected by the rule. *Post* equals one if the fund–quarter observation occurs in the years 2020–2021, and zero otherwise. Fund controls include size, age, expense ratio and performance. As we use fund share-quarter observations, we include fund fixed effects, and additionally include fund size quintile and fund age quintile each interacted with quarter-year fixed effects. We cluster standard errors by fund share class.

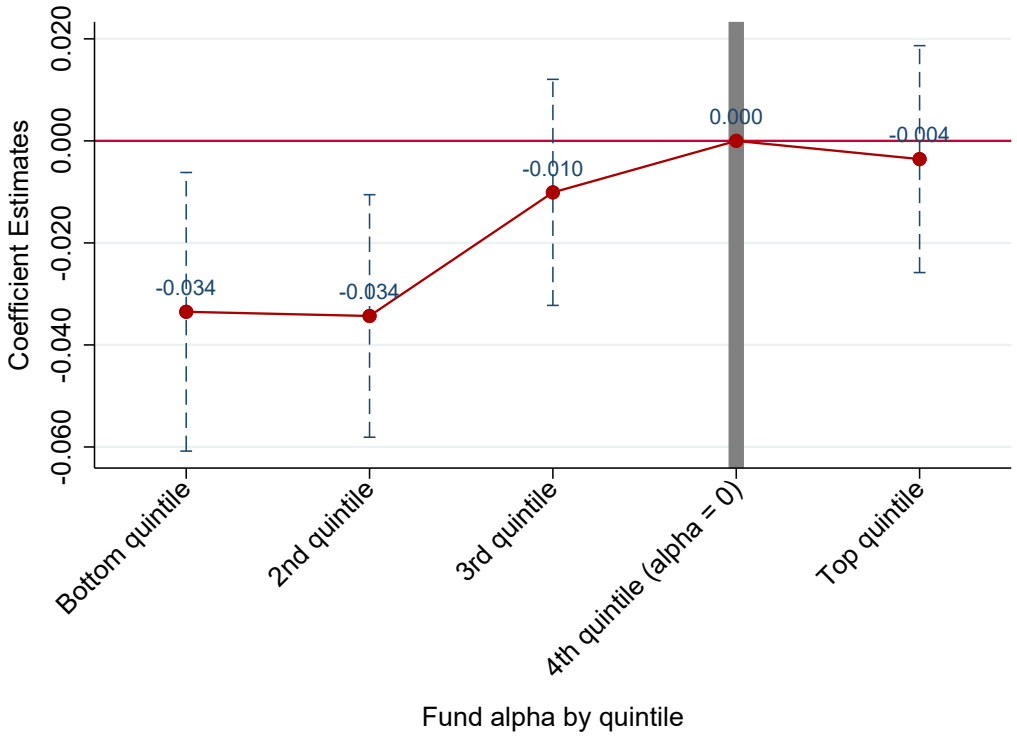

Figure 4: Change in Likelihood of Selling Securities During COVID-19 Crisis in U.S. Post Rule

This figure reports the change in sale likelihood of corporate and municipal bond holdings in the U.S. post liquidity rule by security-level liquidity quintiles. The change is calculated by comparing post rule sale likelihood of holdings against sale likelihood before the rule. The benchmark of change in holdings-level sale probability is Canadian fixed income funds for the same pre-post period. The figure, therefore, plots the coefficient estimates of the triple interaction between U.S./Canada × Pre-Post (cross-crises) × Liquidity quintile. The equation is as follows:

$$\text{Sell}_{k,i,t} = \vec{\beta}_1 \cdot \text{U.S.}_i \cdot \text{Post}_t \cdot \text{Liquidity Quintile}_k + \sum_{j=2} \beta_j \cdot \text{Lower order interaction terms}_{k,i,t}$$
$$+ \sum_j \gamma_j \cdot \text{Controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \nu_k + \varepsilon_{k,i,t},$$

where $Sell_{k,i,t}$ represents a binary variable that is equal to one if fund i sells this specific holding k in quarter t and zero otherwise. $\vec{\beta}_1$ represents a vector of coefficients, corresponding to liquidity quintiles. *U.S.* is an indicator variable equal to one if the fund is domiciled in the U.S. and thus affected by the rule, and zero if it is domiciled in Canada and therefore not affected by the rule. *Post* equals one if the fund–quarter observation occurs in the years 2020–2021, and zero otherwise. Fund controls include size, age, expense ratio and performance. Instruments are divided into five quintiles based on relative liquidity (Liquidity quintile), with the highest quintile being the most liquid bucket. The regression is at the fund-security-quarter level. We include fund and instrument fixed effects as well as fund size quintile and fund age quintile both interacted with quarter-year fixed effects, and cluster standard errors by fund share-class.

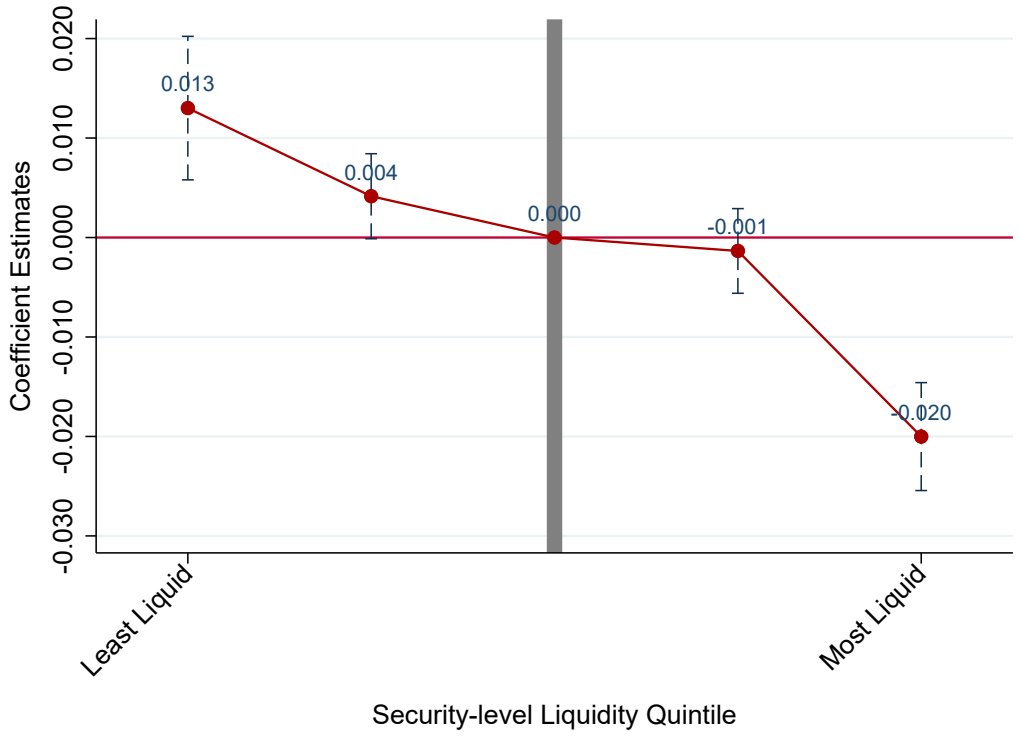

Figure 5: Change in Likelihood of Selling Securities During the COVID-19 Crisis in the U.S. and Canada Post Rule

This figure reports the change in sale likelihood of municipal and corporate bond holdings post liquidity rule by security-level liquidity quintiles in the U.S. and Canada. The change is calculated by comparing post rule sale likelihood of holdings against sale likelihood before the rule, for each liquidity quintile. The figure plots the coefficient estimates of the interaction between Pre-Post (cross-crises) × Liquidity quintile for U.S. (left panel) and Canada (right panel). The equation is as follows:

$$\begin{aligned}\text{Sell}_{k,i,t} =& \vec{\beta}_1 \cdot \text{Post}_t \cdot \text{Liquidity Quintile}_k + \sum_{j=2} \beta_j \cdot \text{Lower order interaction terms}_{k,i,t} \\ &+ \sum_j \gamma_j \cdot \text{Controls}_{i,t} + \text{Fund Chars.}_{i,t} \times \eta_t + \zeta_i + \nu_k + \varepsilon_{k,i,t},\end{aligned}$$

where $Sell_{k,i,t}$ represents a binary variable that is one if fund i sells this specific holding k in quarter t and zero otherwise. $\vec{\beta}_1$ represents a vector of coefficients, corresponding to liquidity quintiles. *Post* equals one if the fund–quarter observation occurs in the years 2020–2021, and zero otherwise. Fund controls include size, age, expense ratio and performance. Instruments are divided into five quintiles based on relative liquidity (Liquidity quintile), with the highest quintile being the most liquid bucket. The regression is at the fund-security-quarter level. We include fund and instrument fixed effects as well as fund size quintile and fund age quintile both interacted with quarter-year fixed effects, and cluster standard errors by fund share-class.

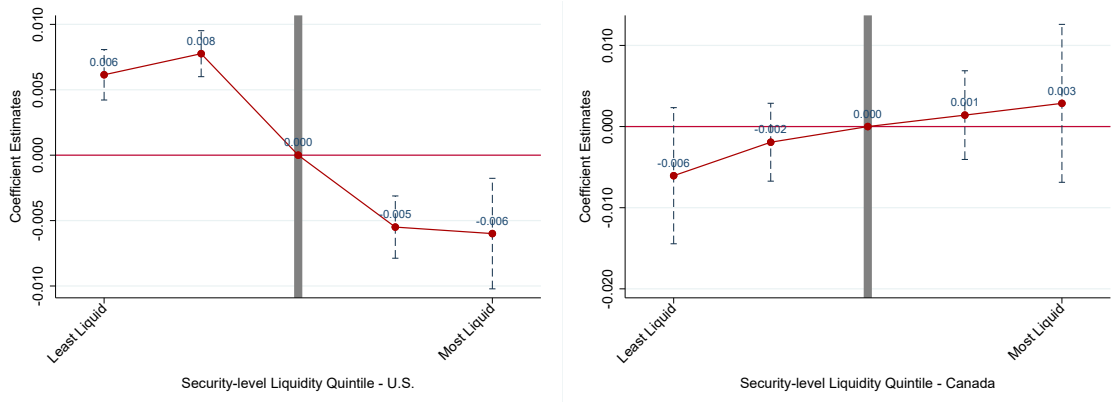

Table 1: Descriptive Statistics of Samples Pre-Post Rule and Cross-Crises

This table provides descriptive statistics for data samples used in our analyses. Observations are at the fund share class-quarter level. *Liquid Holdings (%)* is the percentage of a fund's portfolio held in cash, government securities, or short-term repurchase agreements per Morningstar. *Fund Flow* is calculated as the end-of-quarter month flows. *Fund Exit* is an indicator variable equal to one if a fund exits Morningstar Direct in the next calendar quarter, and zero otherwise. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. *Fund Performance* is the 12-month rolling Morningstar alpha. α_{gjn} is the lagged rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns. All variables are winsorized by year at the 1 and 99 percentile levels.

Panel A: Full Sample, Pre-post rule comparison sample.

	Num. obs.	Mean	Std. Dev.	Median	25$^{\text{th}}$ pctile.	75$^{\text{th}}$ pctile.
Liquid Holdings (%)	328,823	12.4230	20.8883	5.1794	1.8621	14.0973
Fund Flow	328,823	0.0032	0.0810	-0.0016	-0.0159	0.0118
Fund Exits	328,823	0.0430	0.2030	0.0000	0.0000	0.0000
U.S.	328,823	0.5660	0.4956	1.0000	0.0000	1.0000
Fund Age	328,823	2.0641	0.7242	2.0794	1.6094	2.6391
Fund Size	328,823	3.0212	2.3119	2.7213	0.9780	4.6776
Expense Ratio	328,823	1.2387	0.7550	1.1100	0.6700	1.8400
Fund Performance	328,823	-0.0033	0.0073	-0.0024	-0.0069	0.0006

Panel B: Fixed Income Fund Sample, Pre-post rule comparison sample.

	Num. obs.	Mean	Std. Dev.	Median	25$^{\text{th}}$ pctile.	75$^{\text{th}}$ pctile.
Liquid Holdings (%)	137,412	13.7088	19.2016	7.3674	3.2116	16.6511
Fund Flow	137,412	0.0061	0.0838	-0.0010	-0.0148	0.0140
Fund Exits	137,412	0.0344	0.1822	0.0000	0.0000	0.0000
U.S.	137,412	0.5397	0.4984	1.0000	0.0000	1.0000
Fund Age	137,412	1.9620	0.7278	1.9459	1.3863	2.4849
Fund Size	137,412	2.9958	2.2955	2.6955	0.9620	4.6373
Expense Ratio	137,412	1.1073	0.7148	0.9900	0.5500	1.6700
Fund Performance	137,412	-0.0034	0.0057	-0.0023	-0.0060	0.0001
α_{gjn}	137,412	-0.0011	0.0043	-0.0007	-0.0033	0.0013

Panel C: Full Sample, Cross-crises comparison sample.

	Num. obs.	Mean	Std. Dev.	Median	25$^{\text{th}}$ pctile.	75$^{\text{th}}$ pctile.
Liquid Holdings (%)	234,467	11.7959	20.6117	5.0235	1.8210	13.4081
Fund Flow	234,467	0.0020	0.0789	-0.0022	-0.0173	0.0107
Fund Exits	234,467	0.0580	0.2337	0.0000	0.0000	0.0000
U.S.	234,467	0.5538	0.4971	1.0000	0.0000	1.0000
Fund Age	234,467	2.1047	0.7164	2.1972	1.6094	2.6391
Fund Size	234,467	3.0276	2.3400	2.7325	0.9391	4.7101
Expense Ratio	234,467	1.2054	0.7371	1.0800	0.6500	1.7800
Fund Performance	234,467	-0.0011	0.0074	-0.0011	-0.0050	0.0023

Panel D: Fixed Income Fund Sample, Cross-crises comparison sample.

	Num. obs.	Mean	Std. Dev.	Median	25$^{\text{th}}$ pctile.	75$^{\text{th}}$ pctile.
Liquid Holdings (%)	93,681	13.2241	18.3113	7.6615	3.4062	16.7938
Fund Flow	93,681	0.0051	0.0807	-0.0013	-0.0155	0.0132
Fund Exits	93,681	0.0464	0.2104	0.0000	0.0000	0.0000
U.S.	93,681	0.5277	0.4992	1.0000	0.0000	1.0000
Fund Age	93,681	2.0203	0.7101	2.0794	1.6094	2.5649
Fund Size	93,681	3.0092	2.3136	2.7331	0.9400	4.6587
Expense Ratio	93,681	1.0657	0.6908	0.9400	0.5300	1.5900
Fund Performance	93,681	-0.0011	0.0055	-0.0013	-0.0043	0.0015
α_{gjn}	93,681	-0.0010	0.0052	-0.0008	-0.0038	0.0015

Table 2: Descriptive Statistics of Sub-samples Cross-Crises

This table provides descriptive statistics for data samples used in our analyses. Observations are at the fund share class-quarter level. *Liquid Holdings (%)* is the percentage of a fund's portfolio held in cash, government securities, or short-term repurchase agreements. *Fund Flow* is calculated as the end-of-quarter month flows. *Fund Exit* is an indicator variable equal to one if a fund exits Morningstar Direct in the next calendar quarter, and zero otherwise. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. *Fund Performance* is the 12-month rolling Morningstar alpha. α_{gjn} is the lagged rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns. All variables are winsorized by year at the 1 and 99 percentile levels.

Panel A: U.S. Sample (cross-crises)

	Num. obs.	Mean	Std. Dev.	Median	25^{th} pctile.	75^{th} pctile.
Liquid Holdings (%)	49,431	13.1679	19.8314	7.4549	3.0426	17.9905
Fund Flow	49,431	0.0072	0.0820	-0.0002	-0.0157	0.0168
Fund Exits	49,431	0.0484	0.2145	0.0000	0.0000	0.0000
U.S.	49,431	1.0000	0.0000	1.0000	1.0000	1.0000
Fund Age	49,431	2.1164	0.7448	2.1972	1.6094	2.7081
Fund Size	49,431	3.5214	2.4484	3.4774	1.3929	5.3426
Expense Ratio	49,431	0.7778	0.5322	0.6900	0.3900	1.0700
Fund Performance	49,431	0.0005	0.0056	0.0001	-0.0024	0.0030
α_{gjn}	49,431	-0.0005	0.0058	-0.0006	-0.0033	0.0018

Panel B: Canada Sample (cross-crises)

	Num. obs.	Mean	Std. Dev.	Median	25^{th} pctile.	75^{th} pctile.
Liquid Holdings (%)	44,250	13.2869	16.4481	7.9063	3.7221	15.9022
Fund Flow	44,250	0.0028	0.0791	-0.0030	-0.0154	0.0087
Fund Exits	44,250	0.0442	0.2056	0.0000	0.0000	0.0000
U.S.	44,250	0.0000	0.0000	0.0000	0.0000	0.0000
Fund Age	44,250	1.9130	0.6528	1.9459	1.3863	2.3979
Fund Size	44,250	2.4369	2.0038	2.0729	0.6784	3.8475
Expense Ratio	44,250	1.3872	0.7057	1.3300	0.8800	2.0200
Fund Performance	44,250	-0.0028	0.0048	-0.0030	-0.0057	-0.0005
α_{gjn}	44,250	-0.0015	0.0044	-0.0010	-0.0042	0.0011

Panel C: U.S. High Yield Sample (cross-crises)

	Num. obs.	Mean	Std. Dev.	Median	25^{th} pctile.	75^{th} pctile.
Liquid Holdings (%)	4,066	6.1833	11.3353	4.1494	1.9886	6.8834
Fund Flow	4,066	-0.0003	0.0842	-0.0048	-0.0245	0.0112
Fund Exits	4,066	0.0883	0.2838	0.0000	0.0000	0.0000
U.S.	4,066	1.0000	0.0000	1.0000	1.0000	1.0000
Fund Age	4,066	2.3662	0.7213	2.4849	1.9459	2.9444
Fund Size	4,066	3.9046	2.2331	3.9879	2.1423	5.5585
Expense Ratio	4,066	1.0690	0.4664	0.9600	0.7200	1.3800
Fund Performance	4,066	0.0023	0.0086	0.0021	-0.0040	0.0057
α_{gjn}	4,066	0.0025	0.0093	0.0026	-0.0052	0.0065

Panel D: Remaining U.S. Sample (cross-crises)

	Num. obs.	Mean	Std. Dev.	Median	25^{th} pctile.	75^{th} pctile.
Liquid Holdings (%)	45,365	13.7939	20.3041	8.1317	3.2459	19.2809
Fund Flow	45,365	0.0079	0.0818	-0.0001	-0.0148	0.0173
Fund Exits	45,365	0.0448	0.2068	0.0000	0.0000	0.0000
U.S.	45,365	1.0000	0.0000	1.0000	1.0000	1.0000
Fund Age	45,365	2.0940	0.7427	2.1972	1.6094	2.6391
Fund Size	45,365	3.4871	2.4639	3.4172	1.3196	5.3184
Expense Ratio	45,365	0.7517	0.5300	0.6500	0.3700	1.0300
Fund Performance	45,365	0.0004	0.0052	-0.0000	-0.0023	0.0027
α_{gjn}	45,365	-0.0008	0.0053	-0.0007	-0.0033	0.0015

Table 3: Effects of the Rule on the Level of Liquid Holdings of U.S. Funds

This table estimates the effects of the Liquidity Rule on the average holdings of highly liquid securities by U.S. funds compared to Canadian funds. The table conducts fund share class-level regressions, with separate estimates for all funds and for fixed income funds. Columns (1)–(2) and (4)–(5) report estimates for all funds in the U.S. and Canada and columns (3) and (6) report estimates for fixed income funds only. The first half of the table (i.e., columns (1)–(3)) uses fund-level data from 2014–2015 (pre-rule period) and 2020–2021 (post-rule period). The liquidity rule was fully implemented between 2018–2019. The second half of the table uses fund-level data from 2008–2009 (pre-rule Financial Crisis) and 2020–2021 (post-rule COVID-19 market crisis). *Liquid Holdings (%)* is the percentage of a fund's portfolio held in cash, government securities, or short-term repurchase agreements. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *Post* is an indicator equal to one if an observation occurs in 2020–2021 and zero otherwise. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. *Fund Performance* is the 12-month rolling Morningstar alpha. Where indicated, specifications include fund, quarter, fund size quintile × quarter, and fund age quintile × quarter fixed effects. Standard errors, clustered by fund share class, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Liquid Holdings (%)					
	Pre-Post Rule Change			Comparison Between Crises		
	(1)	(2)	FI Only (3)	(4)	(5)	FI Only (6)
U.S. × Post	6.0141***	6.1484***	7.6887***			
	(0.2730)	(0.2845)	(0.4142)			
U.S. × Post (cross-crises)				10.5346***	10.8842***	6.4702***
				(0.5963)	(0.6173)	(0.8337)
Fund Age	-0.3103***	0.3642*	-0.0946	0.1923***	-0.2471	-0.3856
	(0.0605)	(0.1864)	(0.2624)	(0.0728)	(0.1995)	(0.2746)
Fund Size	0.0847***	0.1419***	0.2083***	0.0118	0.0008	-0.0087
	(0.0157)	(0.0540)	(0.0802)	(0.0160)	(0.0520)	(0.0803)
Expense Ratio	-0.0503	-0.0493	0.0222	-0.1341***	-0.1543***	-0.0335
	(0.0361)	(0.0359)	(0.0553)	(0.0393)	(0.0387)	(0.0621)
Fund Performance	-0.3247	0.6157	69.5204***	-29.7210***	-30.8079***	-51.4362***
	(6.0467)	(6.1079)	(14.8825)	(6.7180)	(6.7664)	(19.1131)
Fund FE	Y	Y	Y	Y	Y	Y
Quarter FE	Y	N	N	Y	N	N
Fund Size×Quarter FE	N	Y	Y	N	Y	Y
Fund Age×Quarter FE	N	Y	Y	N	Y	Y
Observations	328,823	328,823	137,412	234,467	234,467	93,681
Adjusted R^2	0.6682	0.6690	0.6160	0.6843	0.6856	0.6100

Table 4: Effects of the Liquidity Rule on the Flow-Performance Sensitivity of Funds

This table estimates the change in flow-performance sensitivity in the U.S. after the Liquidity Rule. The table conducts fund share class-level regressions for fixed income funds. Columns (1) and (4) report estimates for fixed income funds in the U.S. and Canada and columns (2)–(3) and (5)–(6) report estimates separately for the U.S. and Canada. The table uses fund-level data from 2008–2009 (pre-rule Financial Crisis) and 2020–2021 (post-rule COVID-19 market crisis). *Fund Flow*$_{i,t}$ is calculated after adjusting for the return over the last period. α_{gjn} is the rolling one-year alpha, where alpha is calculated using benchmark returns from both the CRSP Total Market Index and the Vanguard Total Bond Market Index. For columns (1)–(3), we use a continuous measure of α_{gjn} and for columns (4)–(6) we split α_{gjn} into Neg. α_{gjn} and Pos. α_{gjn}. Neg. α_{gjn} is equal to the negative values of α_{gjn}, and zero when α_{gjn} is positive. Pos. α_{gjn} is equal to the positive values of α_{gjn}, and zero when α_{gjn} is negative. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *Post* is an indicator equal to one if an observation occurs in 2020–2021 and zero otherwise. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. Specifications include fund, fund size quintile × quarter and fund age quintile × quarter fixed effects. Standard errors, clustered by fund share class, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Fund Flow					
	All FI Funds	US FI Only	CA FI only	All FI Funds	US FI Only	CA FI only
	(1)	(2)	(3)	(4)	(5)	(6)
α_{gjn}	1.7935***	0.4479***	1.7900***			
	(0.3640)	(0.1699)	(0.4660)			
$\alpha_{\text{gjn}} \times$ Post	-0.1619	0.9784***	-0.0754			
	(0.3876)	(0.2274)	(0.4962)			
$\alpha_{\text{gjn}} \times$ Post $\times$ U.S.	1.0440**					
	(0.4165)					
Neg. α_{gjn}				2.9814***	0.8736***	2.6203***
				(0.7157)	(0.3109)	(0.9432)
Neg. $\alpha_{\text{gjn}} \times$ Post				-1.1554	0.9257**	-0.8717
				(0.7294)	(0.3624)	(0.9550)
Neg. $\alpha_{\text{gjn}} \times$ Post $\times$ U.S.				1.9861**		
				(0.7805)		
$\alpha_{\text{gjn}} \times$ U.S.	-1.3249***					
	(0.3888)					
Neg. $\alpha_{\text{gjn}} \times$ U.S.				-2.1664***		
				(0.7607)		
Pos. α_{gjn}				0.5338***	0.2802	1.5087***
				(0.1785)	(0.2094)	(0.3748)
Post $\times$ U.S.	-0.0150***			-0.0103***		
	(0.0034)			(0.0039)		
Fund Age	-0.0255***	-0.0212***	-0.0296***	-0.0259***	-0.0214***	-0.0298***
	(0.0024)	(0.0033)	(0.0037)	(0.0024)	(0.0033)	(0.0037)
Fund Size	0.0016***	0.0005	0.0030***	0.0016***	0.0005	0.0030***
	(0.0005)	(0.0006)	(0.0008)	(0.0005)	(0.0006)	(0.0008)
Expense Ratio	-0.0020***	-0.0057***	-0.0017**	-0.0021***	-0.0057***	-0.0017**
	(0.0006)	(0.0014)	(0.0007)	(0.0006)	(0.0014)	(0.0007)
Fund FE	Y	Y	Y	Y	Y	Y
Fund Size×Quarter FE	Y	Y	Y	Y	Y	Y
Fund Age×Quarter FE	Y	Y	Y	Y	Y	Y
Observations	93,681	49,431	44,250	93,681	49,431	44,250
Adjusted R^2	0.1288	0.1380	0.1211	0.1288	0.1381	0.1211

Table 5: Effects of the Liquidity Rule on Fund Exits

This table estimates the change in fund exits after the Liquidity Rule. The table conducts fund share class-level regressions for fixed income funds. Columns (1), (2), and (6) report estimates for fixed income funds in the U.S. and Canada. Column (3) focuses on fixed income funds in the U.S.. Column (4) focuses on fixed income funds in Canada. Column (5) includes all high yield funds in the U.S. and Canada. The table uses fund-level data from 2008–2009 (pre-rule Financial Crisis) and 2020–2021 (post-rule COVID-19 market crisis). *Fund Exits* is an indicator variable equal to one if the fund exits Morningstar Direct in the next calendar quarter and zero otherwise. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *U.S. HY Fund* is an indicator variable equal to one if a fund is classified as high yield and domiciled in the U.S. and zero otherwise. *CA HY Fund* is an indicator variable equal to one if a fund is classified as high yield and domiciled in Canada and zero otherwise. *Post* is an indicator equal to one if an observation occurs in 2020–2021 and zero otherwise. α_{gjn} is the rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns following Goldstein et al. (2017). *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. Specifications include fund category × country, fund size quintile × quarter and fund age quintile × quarter fixed effects. Standard errors, clustered by fund share class, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Fund Exits					
	FI Funds		US FI	CA FI	High Yield	FI Funds
	(1)	(2)	(3)	(4)	(5)	(6)
Post × U.S.	0.0119***					0.0076***
	(0.0022)					(0.0023)
Post × US HY Fund		0.0571***	0.0537***		0.0723***	
		(0.0066)	(0.0068)		(0.0092)	
Post × CA HY Fund				-0.0016		
				(0.0053)		
Post × HY Fund						-0.0002
						(0.0043)
Post × HY Fund × U.S.						0.0555***
						(0.0078)
α_{gjn}	-0.3414***	-0.1183	-0.1308	0.1724	-0.1003	-0.1191
	(0.1128)	(0.1148)	(0.1360)	(0.1977)	(0.5235)	(0.1150)
Fund Age	-0.0080**	-0.0079**	-0.0408***	0.0239***	-0.0134	-0.0079**
	(0.0034)	(0.0034)	(0.0047)	(0.0047)	(0.0164)	(0.0034)
Fund Size	0.0002	0.0001	0.0009	-0.0027	-0.0023	0.00004
	(0.0010)	(0.0010)	(0.0012)	(0.0018)	(0.0050)	(0.0010)
Expense Ratio	0.0112***	0.0114***	0.0208***	0.0085***	-0.0014	0.0113***
	(0.0010)	(0.0010)	(0.0017)	(0.0013)	(0.0055)	(0.0010)
Fund Category×Country FE	Y	Y	Y	Y	Y	Y
Fund Size×Quarter FE	Y	Y	Y	Y	Y	Y
Fund Age×Quarter FE	Y	Y	Y	Y	Y	Y
Observations	93,681	93,681	49,431	44,250	6,776	93,681
Adjusted R^2	0.2388	0.2393	0.2515	0.2460	0.2340	0.2393

Table 6: Effects of the Liquidity Rule on Sales of Illiquid Bonds and Fund Performance

This table estimates the effect of sale of illiquid corporate and municipal bonds on fund performance after the Liquidity Rule. The table conducts fund share class-level regressions for fixed income funds. The table uses fund-level data from 2008–2009 (pre-rule Financial Crisis) and 2020–2021 (post-rule COVID-19 market crisis). Column (1) estimates the probability of large sales of illiquid corporate and municipal bonds across the rule change period. Columns (2)–(4) estimates fund alpha in response to sales of such illiquid securities across the rule change period, comparing US and CA fixed income funds. Columns (5)–(7) reruns columns (2)–(4) using an indicator for when fund alpha is negative. Columns (2) and (5) utilize all available data for fixed income funds in the U.S. and Canada. Columns (3) and (6) focus on the U.S. fixed income fund subsample. Columns (4) and (7) focus on the Canadian fixed income fund subsample. The variable *Large Sale of Illiquids* is an indicator variable equal to one if a fund-quarter observation is in the 95th percentile of observations in terms of the intensity of sale of illiquid securities (*Sale of Illiquid Holdings)*, and zero otherwise. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero is a fund is domiciled in Canada. *Post* is an indicator equal to one if an observation occurs in 2020–2021 and zero otherwise. α_{gjn} is the rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns following Goldstein et al. (2017). Neg. α_{gjn} is an indicator variable equal to one if α_{gjn} is below zero, and zero otherwise. *Sale of Illiquid Holdings* is the fraction of a fund's corporate and municipal holdings sold in a quarter that are illiquid securities (bottom two quintiles). *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. Specifications include fund, fund size quintile × quarter and fund age quintile × quarter fixed effects. Standard errors, clustered by fund share class, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Large Sale of Illiquids	α_{gjn}			Neg. α_{gjn}		
		All	US	CA	All	US	CA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × U.S.	0.0513**	-0.0022***			-0.0414		
	(0.0218)	(0.0005)			(0.0333)		
Sale of Illiquid Holdings × Post		0.1162***	-0.0532***	0.1080***	-2.6305	4.5439***	-1.6833
		(0.0320)	(0.0184)	(0.0324)	(2.8890)	(1.0887)	(2.8315)
Sale of Illiquid Holdings × Post × U.S.		-0.1624***			7.1532**		
		(0.0369)			(3.0942)		
Sale of Illiquid Holdings × U.S.		0.0387*			-0.6291		
		(0.0225)			(2.1411)		
Sale of Illiquid Holdings		-0.0481**	-0.0079	-0.0296	0.3105	-0.2162	-0.6604
		(0.0195)	(0.0111)	(0.0191)	(2.0470)	(0.5953)	(1.9422)
Fund Age	-0.0059	-0.0002	-0.0001	-0.0007**	0.0173	0.0224*	0.0082
	(0.0046)	(0.0002)	(0.0002)	(0.0003)	(0.0116)	(0.0122)	(0.0280)
Fund Size	0.0010	0.00002	0.00003	-0.0001	-0.0084**	-0.0103***	-0.0025
	(0.0014)	(0.00004)	(0.00005)	(0.0001)	(0.0034)	(0.0037)	(0.0090)
Expense Ratio	-0.0001	-0.0008***	-0.0008***	-0.0008***	0.1040***	0.0933***	0.1163***
	(0.0015)	(0.0000)	(0.0001)	(0.0000)	(0.0046)	(0.0061)	(0.0072)
Fund FE	Y	Y	Y	Y	Y	Y	Y
Fund Size×Quarter FE	Y	Y	Y	Y	Y	Y	Y
Fund Age×Quarter FE	Y	Y	Y	Y	Y	Y	Y
Observations	34,797	34,797	24,250	10,547	34,797	24,250	10,547
Adjusted R^2	0.3467	0.5503	0.5686	0.4928	0.5076	0.5240	0.4869

Table 7: Effects of the Liquidity Rule on Fund Liquid Holdings Conditional on Outflows

This table estimates the effects of the Liquidity Rule on the highly liquid holdings of fixed income funds conditional on fund outflows. The table conducts fund share class-level regressions for fixed income funds. The table uses fund-level data from 2008–2009 (pre-rule Financial Crisis) and 2020–2021 (post-rule COVID-19 market crisis). There are three measures of outflows: 1) *Outflow*: a measure from Morningstar Direct of fund flows multiplied by negative one where fund inflows are set to zero; 2) *Outflow (Top Dec.)*: an indicator that equals one if the share class experienced outflows in a quarter that are in the top decile of all flows and zero otherwise; 3) *Outflow (Top Dec.)*: an indicator that equals one if the share class experienced outflows in a quarter that are in the top decile of all flows within U.S. or Canada and zero otherwise. *Liquid Holdings (%)* is the percentage of a fund's portfolio held in cash, government securities, or short-term repurchase agreements. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. α_{gjn} is the lagged rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns. Specifications include fund, fund size quintile $\times$ quarter and fund age quintile $\times$ quarter fixed effects. Standard errors, clustered by fund share class, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Liquid Holdings (%)				
Outflow Measure:	Outflow	Outflow (Top Dec.)	Outflow (Top Dec.) US-only	Outflow (Top Dec.) CA-only	Outflow (US/CA Top Dec.)
	(1)	(2)	(3)	(4)	(5)
U.S. $\times$ Post	7.9208***	8.1023***			8.0234***
	(0.9816)	(0.9807)			(0.9761)
U.S. $\times$ Post $\times$ Outflow Measure	20.4276***	3.4123**			4.4275**
	(6.2124)	(1.7332)			(1.8950)
U.S. $\times$ Outflow Measure	-20.9592***	-4.1162**			-5.1410***
	(6.0880)	(1.6933)			(1.8615)
Post $\times$ Outflow Measure	-6.3511	-0.0613	3.1280***	0.2108	-1.5604
	(5.3354)	(1.4096)	(0.9844)	(1.3979)	(1.6328)
Outflow Measure	5.7552	0.2633	-3.6111***	0.0461	1.6899
	(5.3061)	(1.3922)	(0.9400)	(1.3819)	(1.6158)
Fund Age	-0.2405	-0.2224	-1.7660***	1.2508***	-0.2344
	(0.2989)	(0.2983)	(0.5490)	(0.2762)	(0.2983)
Fund Size	-0.0583	-0.0596	-0.2033*	0.1618	-0.0614
	(0.0851)	(0.0851)	(0.1212)	(0.1110)	(0.0850)
Expense Ratio	-0.0125	-0.0135	-0.5346***	0.2175***	-0.0079
	(0.0550)	(0.0550)	(0.1973)	(0.0500)	(0.0551)
α_{gjn}	18.3856	19.0616	-44.6289	170.7514***	18.7297
	(23.0023)	(23.0336)	(34.1631)	(26.2260)	(23.0199)
Fund FE	Y	Y	Y	Y	Y
Fund Size$\times$Quarter FE	Y	Y	Y	Y	Y
Fund Age$\times$Quarter FE	Y	Y	Y	Y	Y
Observations	71,530	71,530	35,109	36,421	71,530
Adjusted R^2	0.6290	0.6290	0.6012	0.6846	0.6290

Table 8: Effects of the Liquidity Rule on Sale of Securities Conditional on their Liquidity

This table estimates the effects of the Liquidity Rule on the likelihood of sale of corporate and municipal bonds by fixed income funds in the U.S. and Canada conditional on the liquidity-level of each bond. The regressions are at the fund-security level. The data sample is the universe of corporate and municipal bonds held by U.S. and Canadian fixed income funds. The source of data is Morningstar Direct. Columns (1) and (2) include all U.S. and Canada fixed income funds. Columns (3) and (4) utilize the specification in Column (2), separately for U.S. and Canada subsamples. *Sell Likelihood* is an indicator equal to one if the instrument is sold in that quarter by a fund and zero otherwise. Instruments are divided into five quintiles based on their relative liquidity (*Liquidity quintile*). The highest quintile (i.e., five) is the most liquid bucket. *U.S.* is an indicator variable equal to one if a fund is domiciled in the U.S. and zero if the fund is domiciled in Canada. *Post* is an indicator equal to one if an observation occurs in 2020–2021 and zero otherwise. *Fund Age* is the natural logarithm of one plus the age in years of the fund calculated using its reported inception year in Morningstar Direct. *Fund Size* is the natural logarithm of one plus the net asset value (in millions of dollars) of the share class. *Expense Ratio* is a fund's expense ratio in percentage points. α_{gjn} is the lagged rolling 12-month alpha calculated using benchmark returns from the CRSP value-weighted market and Vanguard Total Bond Market Index Fund returns. Where indicated, specifications include fund, instrument, fund quarter, fund size-quintile $\times$ quarter and fund age-quintile $\times$ quarter fixed effects. Standard errors, clustered by fund and instrument identifier, are in parentheses. Statistical significance is denoted as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, respectively.

	Sell Likelihood			
	U.S./Canada		U.S.	Canada
	(1)	(2)	(3)	(4)
U.S. $\times$ Post	0.0076	0.0093		
	(0.0094)	(0.0094)		
U.S. $\times$ Post $\times$ Liquidity quintile	-0.0085**	-0.0083**		
	(0.0037)	(0.0037)		
Post $\times$ Liquidity quintile	0.0049	0.0047	-0.0037***	0.0019
	(0.0036)	(0.0036)	(0.0008)	(0.0028)
U.S. $\times$ Liquidity quintile	0.0011	0.0010		
	(0.0029)	(0.0029)		
Liquidity quintile	-0.0015	-0.0014	-0.0007	0.0031
	(0.0028)	(0.0028)	(0.0006)	(0.0020)
Fund Age	0.0003	0.0057	0.0030	0.0254
	(0.0044)	(0.0073)	(0.0077)	(0.0251)
Fund Size	-0.0008	-0.0034	-0.0033	-0.0080
	(0.0013)	(0.0026)	(0.0024)	(0.0086)
Expense Ratio	0.0099**	0.0115**	0.0159***	0.0061
	(0.0045)	(0.0046)	(0.0061)	(0.0070)
α_{gjn}	-0.0915	-0.1234	-0.0319	-1.4943**
	(0.1250)	(0.1116)	(0.1104)	(0.6820)
Fund FE	Y	Y	Y	Y
Instrument FE	Y	Y	Y	Y
Quarter FE	Y	N	N	N
Fund Size$\times$Quarter FE	N	Y	Y	Y
Fund Age$\times$Quarter FE	N	Y	Y	Y
Observations	10,797,145	10,797,145	9,646,867	1,150,278
Adjusted R^2	0.1451	0.1469	0.1298	0.2510

Appendix: For Online Publication Only

A Canadian Regulatory Developments

Table A.1: Major Regulatory Developments for Canadian Mutual Funds (NI 81-102), Excluding Money Market-Specific Rules

Date (Effective)	Amendment / Rule	Key Provisions & Relevance
June 27, 1997	*NI 81-102 Proposed*	• Initiated a public comment period to codify/standardize rules for Canadian mutual funds. • Covered fund distributions, redemption rights, and investment restrictions. • No explicit minimum liquidity required to be held by funds.
Feb 1, 2000	*NI 81-102 Finalized*	• Formalized restrictions on derivatives, leverage, and conflicts of interest for mutual funds. • Set standards for valuation, redemption rights, and risk disclosure. • Still no prescribed liquidity buckets or minimum liquidity buffer.
May 2, 2001	*Amendment to NI 81-102*	• Clarified investment concentration rules, including index-fund-specific exceptions. • Increased fee transparency for various classes and structures. • No new bright line liquidity provisions.
Dec 31, 2003	*Amendment to NI 81-102*	• Introduced detailed requirements for Fund-of-Fund (FoF) structures (e.g., layered fees). • Addressed additional conflict-of-interest rules in FoF contexts. • No direct liquidity changes affecting non-money market mutual funds.
Nov 1, 2006	*Amendment to NI 81-102*	• Clarified restrictions and requirements related to self-dealing by fund managers and related-party transactions. • Required enhanced disclosure on potential conflicts of interest. • No introduction of new mandated liquidity thresholds.

(Continued on next page)

(Table A.1 continued)

Date (Effective)	Amendment / Rule	Key Provisions & Relevance
Sep 8, 2008	*Amendment to NI 81-102*	• Occurred shortly before the Global Financial Crisis. • Required uniform NAV calculations and clarified expense ratio disclosure for mutual funds. • Did not establish new liquidity constraints for bond or equity funds.
Jan 1, 2011	*Amendment to NI 81-102*	• Revised disclosure rules; integrated "Fund Facts" into offering documents to standardize reporting. • Aimed to improve comparability and transparency of fees, performance, and risks for investors. • No new mandated liquidity buffers for non-MMF products.
Apr 30, 2012	*Modernization (Phase 1)*	• Part of an ongoing CSA initiative to update investment fund product regulation. • Continued emphasis on a principles-based approach to liquidity risk (no prescriptive thresholds for highly liquid minimum). • Introduced certain clarifications on allowable instruments and trading practices.
Sep 18–22, 2014	*Modernization (Phase 2 – Part 1)*	• Extended regulations to certain non-redeemable investment funds and ETFs. • Maintained the existing approach for liquidity risk management. • Encouraged best practices for general oversight but did not impose rules requiring a highly liquidity minimum.
Sep 1, 2017	*Amendment to NI 81-102*	• Standardized the methodology for mutual funds to calculate and disclose investment risk level. • Focused on comparability of reported fund risk to investors in regulatory filings. • Unrelated to liquidity management.
Jan 3, 2019	*Modernization (Phase 2 – Part 2)*	• Targeted "Alternative Funds" using more complex strategies (e.g., derivatives, leverage). • Introduced short-selling parameters and additional reporting requirements. • Did not create new liquidity mandates.

(Continued on next page)

(Table A.1 continued)

Date (Effective)	Amendment / Rule	Key Provisions & Relevance
Sep 18, 2020	*CSA Staff Notice 81-333*	• Released amid the COVID-19 market stress to highlight best practices in liquidity risk management. • Reiterated fund managers' fiduciary duty to fund investors; provides only a discussion of appropriate liquidity risk management. • Contrasts with the U.S. SEC's Rule 22e-4 (the "Liquidity Rule"), which imposes explicit liquidity classifications/buffers.

B Calculation of Bond-Level Liquidity Measures

This appendix details how we construct the liquidity measures for each bond in our sample using quarterly fund holdings from Morningstar. As we do not observe direct transaction-level trade data, we instead rely on changes in fund holdings of each bond to approximate its trading intensity and price responsiveness. We then map these proxies into liquidity quintiles, which we use to analyze how funds manage less liquid assets around the Liquidity Rule.

We start with quarter-end snapshots of each fund's portfolio, indicating the par value (or share) of each bond (CUSIP) held. For each bond, we also rely on the fund's reported valuation (or record an average price) at the end of every quarter, along with the same variables from the previous quarter. By comparing quarter-over-quarter changes in holdings at the *fund* level—e.g., if a particular fund's stake in Bond A rises from 100 units to 125 units, we register a purchase of 25 units—we capture each fund's net trading activity for that bond. We then aggregate these per-fund changes across all funds to estimate how actively a bond is being traded in the mutual fund sector. Intuitively, if a bond's holdings fluctuate substantially across many funds, it likely reflects higher trading liquidity. Conversely, a bond whose holdings remain largely unchanged over time is presumably less liquid. These quarterly changes form the basis for our bond-level liquidity measures, which we further refine by taking rolling four-quarter averages, as described below.

We employ three key measures to capture different facets of a bond's liquidity. Each measure is calculated on a rolling four-quarter basis, i.e., we take the mean of the most recent four quarters' values:

1. **Change-in-Holdings Intensity (Share Volume):** We sum up the absolute change in a bond's holdings across all funds each quarter, then scale by the total holdings of that bond. A high ratio indicates robust trading activity (either buying or selling), suggesting greater liquidity.

2. **Change-in-Holdings Intensity (Count of Funds):** We track how many funds, out of those holding a given bond, either increase or decrease their positions from one quarter to the next.

If many funds are transacting in this bond, it is probable that the bond is relatively easy to buy or sell. We scale the measure by the total number of funds holding the bond in that quarter.

3. **Price Impact:** We adapt the classic Amihud (2002) price-impact measure by relating quarter-over-quarter price divided by the total net changes in bond holdings. Any bond with no trading activity gets a value of one for the net changes in bond activity to avoid having zero in the denominator. A bond that exhibits large price moves for modest net shifts in holdings typically indicates lower liquidity. For interpretability, we invert or negatively scale the ratio so that larger final values imply higher liquidity.

We then calculate the composite measure of liquidity as follows. First, in each quarter, we separately rank every bond along each of the three dimensions (share-volume intensity, count-of-funds intensity, and price impact). Second, for each measure, we classify bonds into five quintiles. Quintile one represents the least liquid bonds in that measure, and quintile five represents the most liquid. Finally, after assigning each bond a rank (one through five) in each measure, we compute a simple average of the three rank values to create our composite measure.

In our analyses, we employ this composite quintile measure to distinguish "less liquid" from "more liquid" bonds when analyzing how funds adjust their portfolios around the Liquidity Rule rule. For example, if U.S. funds reduce sales of quintile five (most liquid) bonds, yet increase sales of quintile one (least liquid) bonds post-rule, this pattern would indicate an increased willingness to offload illiquid assets—potentially contributing to run incentives, consistent with the theoretical insights in Zeng (2017).