Derivative Speculation and Financial Fragility: Evidence from Corporate Bond Mutual Funds

Abstract

Using derivative data from a novel SEC filing, I categorize corporate bond mutual funds into those that use derivatives for speculative versus hedging purposes. I document that bond funds that utilize derivatives for speculations are more inclined to liquidate non-derivative assets to meet payment obligations of derivative positions during the Covid-19 crisis, particularly for funds with limited liquid buffers. These forced liquidations generate substantial selling pressure in bond markets, causing sizable asset price drops and excess return volatility. My findings reinforce the recent regulatory concerns regarding the potentially destabilizing effects of speculative derivative usage among mutual funds.

1. Introduction

The use of derivatives has become prevalent in the mutual fund industry.[1] While fund managers are usually expected to use derivative instruments to reduce portfolio risk exposures, some managers often instead exploit derivatives' flexibility to bet on changing market conditions.[2] Extensive derivative usage could severely threaten financial market stability and has raised significant regulatory concerns. As SEC Commissioner Caroline Crenshaw warns, "many registered funds' reliance on derivatives and leverage to achieve their investment objectives could lead to disaster in times of prolonged or dramatic market stress."[3]

Despite regulatory concerns regarding derivative uses of open-end mutual funds, little academic research has documented the negative consequences of derivative usage for financial market stability. Extant studies suggest that fund managers can effectively manage portfolio risk exposures through derivative instruments without destabilizing financial markets (Koski and Pontiff, 1999; Aragon et al., 2019; Jiang et al., 2021; Sialm and Zhu, 2021). The literature on mutual fund fragility risk instead highlights that redemption-induced trading should be the predominant source of financial fragility (e.g., Coval and Stafford, 2007). However, anecdotal evidence reveals policymakers' concern. In the financial crisis of 2007-2008, two fixed-income funds managed by Oppenheimer Funds, Inc. suffered sharp losses from their tremendous exposure to commercial mortgage-backed securities ("CMBS") via total return swaps (SEC Release No.

[1] The Proposing Release of Rule 18f-4 emphasizes that mutual funds have used derivatives in a wide range of reference assets such as stocks, bonds, foreign currencies, interest rates, and market indices. Derivative instruments are also diverse, including forwards, futures, swaps, swaptions, and options. Note that Rule 18f-4 is new regulation adopted by the SEC in October 2020 to standardize the derivative usage of mutual funds. See more details in the institutional background.

[2] The Proposing Release also indicates that compared to direct investments, derivative investments help fund managers respond to market conditions, lower trading costs, adjust risk exposures more quickly, and obtain exposure to inaccessible reference assets (e.g., foreign currency, commodity, and interest rate).

[3] See https://www.sec.gov/news/public-statement/crenshaw-derivatives-2020-10-28

30099). When the CMBS market crashed later, two funds' highly leveraged swap positions triggered huge liabilities and forced them to liquidate non-derivative holdings to meet these obligations.

In this article, I offer a first look at the frequency of derivative usage by corporate bond mutual funds and explore how their derivative uses affect bond market stability. Since the market impacts of derivative usage might vary depending on its underlying motives, I emphasize contrasting the effects of derivative uses designed for speculative purposes versus that motivated by hedging reasons. The corporate bond fund industry is well-suited for studying this question. The liquidity transformation—investing in illiquid corporate bonds while allowing daily redemptions to fund clients—brings about strategic complementarities, i.e., investors prefer to redeem ahead of others to evade liquidation costs (Diamond and Dybvig, 1983). Bond funds' concave flow-to-performance relationship indicates that their fund outflows are more sensitive to bad performance (Goldstein et al., 2017). Hence, compared to equity counterparts, corporate bond funds' flow-driven liquidation exerts larger price pressure on securities markets, and fund managers must take more precautionary steps to deal with investor redemptions (Morris et al., 2017; Cai et al., 2019; Jiang et al., 2021).

I start with the summary statistics of bond funds' derivative usage. During my sample period, roughly 60% of corporate bond funds hold at least a derivative position. Although bond funds can trade credit/currency derivatives to manage credit or currency risk exposures, bond funds predominantly use interest rate derivatives to safeguard against interest rate fluctuations. Derivative positions entail substantial leverage risks. Despite a trivial derivative asset weight (2% of fund TNA), the corresponding notional amount can be as large as 32% of fund TNA. Such a high level of leverage also implies that derivative returns account for a significant portion of fund total return. Specifically, approximately 20% of funds have derivative returns equal to their non-derivative returns in magnitude.

Since bond funds can use derivatives for speculative and hedging purposes, I classify funds' derivative usage based on correlations between derivative and non-derivative returns. A fund whose derivative returns are positively (negatively) correlated with non-derivative returns during a specified period falls into the derivative speculators (hedgers) group. Over my sample period, around 40% of derivative funds focus on speculative activities, whereas about 60% of derivative users engage in derivative transactions to hedge their non-derivative assets.[4] Then, I document that funds with risk management demands, such as those with less cash reserve, higher portfolio maturity, and high sensitivity to bond risk factors, are more likely to hold hedging derivative positions to protect against unfavorable conditions. Moreover, risk-tolerant funds, proxied by high fund return volatility, tend to exploit derivatives' unique traits to speculate on fluctuating market conditions.

I next contrast the bond liquidation behavior of the two derivative user groups during the Covid-19 periods. Because the liquidity crunch in the Covid-19 crisis triggers significant losses for funds' speculative derivative positions, these funds with scarce liquid reserves tend to scale down bond holdings to meet payment obligations of their leveraged derivative positions. The opposite operates for derivative hedgers. Their hedging derivative positions help them cancel out the loss of non-derivative securities, lowering the likelihood of forced liquidations. Consistent with these views, I uncover that funds using derivatives for speculative (hedging) purposes before the Covid-19 periods unwind more (less) bond holdings than derivative nonusers during the crisis. Since I control for contemporaneous fund flows and prior fund performance, my liquidation result

[4] I compute each fund's return correlation using all the return observations in this test.

is incremental to the effects of investor redemptions. Regarding economic magnitude, derivative speculators (hedgers) decrease (increase) their corporate bonds holdings by 1.078% (1.136%) relative to derivative nonusers, representing 6.7% (7.1%) of the sample average. In comparison, a one-standard-deviation increase in contemporaneous fund flows corresponds to a 4.25% increase in bond liquidations, roughly four times as large as the economic magnitudes of derivative speculation/hedging.

Cross-sectional tests display the heterogeneities among the fire-selling activities of derivative funds. First, bond funds mainly sell liquid corporate bonds to meet the payment obligations of speculative derivative positions, indicating that during a turbulent time, derivative speculators tend to liquidate relative liquid assets to avoid short-term liquidation costs (Scholes, 2000; Ma et al., 2022). Furthermore, the forced liquidations appear concentrated amid derivative speculators with heavily leveraged positions or inadequate liquid cushions. The intuition is that heavily leveraged derivative positions trigger more losses and compel derivative speculators to unwind more bond holdings to satisfy corresponding payment obligations. During an economic downturn, liquid buffers play a crucial role in alleviating forced liquidations (Morris et al., 2017; Chernenko and Sunderam, 2020). Funds short of such a liquidity management tool must scale down non-derivative assets to meet the margin requirements of speculative derivative positions.

Given that speculative derivative usage leads to forced liquidations, I test for the asset pricing implications of bond funds' derivative speculations. In the spirit of Coval and Stafford (2007) and Brunnermeier and Pedersen (2009), I document that excessive selling by derivative speculators exerts substantial price pressure on corporate bond markets and causes a considerable price decline during market stress. Concretely, corporate bonds primarily owned by derivative speculators before the Covid-19 crisis experienced a price depression once the pandemic began.

The economic magnitude is sizable: Bonds mainly owned by derivative speculators experience an additional 10.02 basis point drop in daily returns, representing 13% of the median daily bond return during the crisis. Once the Fed intervenes after March 23, 2020, these hard-beaten bonds exhibit a greater price reversal. These results are robust to including rich fixed effects that remove time-varying common exposures at the issuer, rating, and industry level, mitigating the possibility that bond-issuer fundamentals rather than mutual fund selling pressure explain my findings (Choi et al., 2020). Because leverage-induced liquidations introduce non-fundamental risks, I find that bonds heavily exposed to derivative speculations exhibit higher return volatility than low-exposure counterparts during and after the Covid-19 crisis. In terms of economic magnitude, a one-standard-deviation increase in derivative speculators' ownership raises monthly bond return volatility by 0.117% (0.041%) during the Covid-19 pandemic (post-pandemic), equivalent to 9.5% (0.03%) of the sample mean.

My empirical findings have implications for the recent SEC reform governing mutual funds' derivative usage (Rule 18f-4). The new regulation aims to provide a standardized guideline prohibiting destructive derivatives uses amid mutual funds, thereby protecting investor interests. Specifically, Rule 18-f4 mandates funds to adopt an independent risk management program that monitors derivative positions' risk levels and imposes an explicit VaR limit to alleviate disruptive effects of fund leverage risk. Despite these novel changes, my paper documents that mutual funds utilize derivatives for speculative and hedging purposes, and different derivative uses could generate distinct outcomes for financial market stability. Disclosing funds' motives of derivative uses can improve fund shareholders' welfare and facilitate policymakers' oversight. Furthermore, my analysis suggests that the destabilizing impact of funds' derivative usage primarily comes from leverage risks of derivative positions. Hence, more reliable leverage risk metrics could mitigate the potential disrupting effects of funds' leveraged derivative positions.

This paper advances the growing literature on the derivative use of asset managers. As a crucial class of derivatives end-users, institutional investors exploit the flexibility of derivative instruments to enhance portfolio performance and manage risk exposures (Chen, 2011; Aragon and Martin, 2012; Aragon, Li, and Qian, 2019; Aragon, Martin, and Shi, 2019; Jiang, Ou and Zhu, 2021; Sialm and Zhu, 2021; Kaniel and Wang, 2021). Unlike these studies, my paper directly explores how different derivative uses of asset managers impact financial market stability. Specifically, I focus on corporate bond mutual funds that are more susceptible to financial fragility and classify them into those that utilize derivatives for speculative and hedging purposes. Bond funds' speculative derivative usage introduces severe fragility risks to underlying securities due to their leverage-induced fire-sale during market uncertainty. In contrast, gains from hedging derivative positions compensate funds for their loss of non-derivative holdings, decreasing the likelihood of forced liquidations.

Second, my analysis sheds new light on the determinants of the corporate bond fund fire sale. Existing literature generally attributes bond funds' forced liquidations to their liquidity-mismatch structure (Chen, Goldstein, and Jiang, 2010; Goldstein, Jiang, and Ng, 2017; Falato, Goldstein, and Hortascu, 2021). Concretely, bond funds predominantly invest in illiquid bond markets while providing daily liquidity provisions for their clients, rendering long-term fund holders bear liquidation costs when funds experience outflows. Hence, liquidity transformation makes bond funds vulnerable to investor withdrawals and forces them to engage in unprofitable flow-induced trading (Jiang, Li, and Wang, 2021; Ma, Xiao, and Zeng, 2022; Li, O'Hara, and Zhou, 2022). After controlling for the effect of fund flows, I detect that bond funds' derivatives speculative usage can lead to incremental liquidations straining bond markets. The economic channel can also arise even without investor redemptions. Leveraged derivative positions trigger substantial obligation payments during market turmoil. Derivative speculators must fire-sell bond holdings if they lack enough liquid cushions to meet relevant obligations.

Finally, my study extends the literature that unveils the implications of institutional investors' characteristics for financial market stability. Some attributes, such as funding constraints and the short-term investor horizon, prompt selling pressure on portfolio holdings and thus threaten financial market stability (Aragon and Strahan, 2012; Ben-David, Franzoni, and Moussawi, 2012; Cella, Ellul, and Giannetti, 2013). On the contrary, some asset managers' behavior can stabilize financial markets (Anand, Jotikasthira, and Venkataraman, 2020; Chernenko and Sunderam, 2020).[5] My analysis shows mutual funds' different derivatives usage can have distinct market impacts. The speculative derivative usage can cause selling pressure on non-derivative holdings and destabilize corresponding markets. In contrast, derivative positions for hedging purposes compensate funds for their loss of non-derivative assets, reducing forced liquidations.

2. Institutional Background

2.1 Regulations on Mutual Funds' Derivative Usage

This section elaborates on the history of regulations on mutual funds' use of derivatives. Contrary to a narrative that complex derivative instruments are prohibitive for mutual funds, no official policies prevent mutual funds from engaging in derivative transactions. However, to alleviate the adverse impact of excessive leverage, Section 18 of the Investment Company Act of

[5] For example, the liquidity provision from a subset of corporate bond funds mitigates bonds' fragility risk induced by liquidity-demanding funds (Anand, Jotikasthira, and Venkataraman, 2020). Chernenko and Sunderam (2020) show that some equity funds hoard cash to internalize liquidation costs of future fire sales, thereby reducing the volatility of held securities and negative externalities to peer funds.

1940 imposes constraints on registered investment companies' issuance of senior securities evidencing indebtedness, including various derivative investments that can incur future payments during their lifespan. If a fund decides to trade derivatives, it should at least maintain an asset coverage ratio of 300 % immediately after such issuance. For example, a mutual fund with $100 million in assets can only invest in derivative instruments with future obligations of $50 million. In this situation, that fund's asset coverage ratio, the ratio of its net asset value ($150 million) to the market value of the derivative position ($50 million), exactly equals the regulatory limit of 300%.

The 1979 SEC Release 10666 relaxes the Section 18 limits on particular senior securities such as reverse repurchase agreements, short sales, and derivatives. Under the new framework, registered investment companies can be exempt from the asset coverage requirement if the registered funds segregate sufficient liquid assets to cover potential future losses of their derivative positions. The SEC believes that the appropriate use of segregated accounts ensures that a registered fund has enough liquid resources to meet possible obligations for its derivative transactions, thereby effectively limiting its risk of loss.[6]

Although lifting Section 18 constraints in Release 10666 can theoretically mitigate the adverse consequences of mutual funds' speculative activities via derivative instruments, implementing Release 10666 generates additional concerns for policymakers. First, the loose definition of segregated accounts leads to varying practices regarding the amount and type of liquid assets in segregated accounts.[7] Meanwhile, disparate market practices challenge SEC staff to

[6] A segregated account freezes a fund’s certain assets and makes them unavailable for trading. Policymakers believe that a proper segregation practice is equivalent to placing a practical limit on the amount of leverage a fund can undertake.

[7] Release 10666 states that the segregated account should only consist of liquid holdings like cash, Treasury securities, or high-rated debt obligations. However, other relatively illiquid assets of equal value can sometimes replace existing liquid ones in such an account. Regardless of the asset type, each asset in the segregated account needs to be marketed to market daily.

evaluate a fund's compliance with corresponding rules. Second, relaxing the Section 18 requirement for derivative transactions makes it easy for mutual funds to take excessive leverage and engage in unduly speculations, raising the possibility that certain funds cannot pay off their substantial obligations during market stress.

To address the above concerns, the SEC proposes Rule 18f-4 to officially standardize mutual funds' use of derivatives.[8] The first proposal in 2015 imposed restrictive asset segregation requirements and explicit limits on a fund's notional exposure of its derivative positions. In response to criticism that such requirements in the 2015 proposal could hinder funds' use of derivatives for hedging purposes, the SEC re-proposed multiple novel flexible regulations in 2019 that can inhibit negative consequences of derivative speculations and encourage beneficial hedging practices.

The final version of Rule 18f-4 rescinds the existing framework of Release 10666 and includes three new restrictions for mutual funds' use of derivatives. First, registered funds with sufficient derivative transactions must adopt a written risk management program independent of their portfolio management.[9] Program managers are accountable for identifying and assessing potential funds' derivative risks by routinely performing stress testing, back testing, internal reporting, and program review. Funds' board directors need to approve the designation of the derivative risk managers, who should periodically report details on program implementation and relevant results of risk management practices.[10] Second, funds utilizing derivative instruments

---

[8] Rule 18f-4 was initially proposed by the SEC on 11 December 2015, re-proposed on 25 November 2018, and eventually adopted on 2 November 2020. All mutual funds other than money market funds must comply with Rule 18f-4 before 19 August 2022.

[9] A typical threshold for adopting such a risk management program is for funds whose aggregate derivative notional exposure exceeds 50% of their fund net assets.

[10] The program manager should actively assess diverse derivative risks such as leverage, market, counterparty, liquidity, or operational risk. In addition, the manager needs to monitor whether funds' derivative usage resonates with their investment guidelines and disclose pertinent information to the board of directors.

should restrict their leverage by complying with an outer VaR limit.[11] Funds can choose a relative VaR test or an absolute VaR test. By computing the relative VaR, funds must select an appropriate reference portfolio, either a suitable benchmark index or the funds' portfolio of the non-derivative assets. Third, funds must maintain records on derivative risk to facilitate the investigation of funds' board members and SEC compliance staff. Examples contain written policies and procedures of a funds' derivative risk management program, stress/backtesting results, documents about internal reports, escalation of material risks, and actions of complying with leverage risk limits.

2.2 Information on derivative instruments used by corporate mutual funds

This subsection describes corporate bond funds' incentives for using derivatives and the characteristics of their commonly used derivative instruments. Corporate bond funds are generally subject to interest rate, credit, exchange rate, political, liquidity, and inflation risks (Fabozzi and Mann, 2012). To manage exposure to these bond risk factors, funds may use a variety of derivative instruments. Derivatives enable fund managers to exploit fluctuating market conditions with low transaction costs, enhance the exposure to specific asset classes with tiny capital outlays, sidestep limits of arbitrage, and enter into inaccessible markets such as foreign currency and risky securitized debts. Nevertheless, the use of derivatives also entails exotic risks. For instance, counterparties may fail to fulfill the terms of derivative contracts; excessive leverage risk can trigger substantial payment obligations for derivative users during market turbulence.

Corporate bond funds usually utilize three types of derivative contracts. First, they may hedge against or bet on foreign currency fluctuations via currency forwards. Second, bond funds

[11] The relative VaR cannot exceed 200 % of the VaR of the benchmark portfolio. The absolute VaR should be below 15% of fund net assets.

can enter into plain vanilla interest rate swaps to reduce or increase portfolio sensitivity to changes in benchmark interest rates (i.e., LIBOR rate). Funds may adjust their portfolio duration through Treasury futures. Third, funds that worry about the default of their underlying bond holdings prefer to buy CDS protection and pay periodic premiums to CDS sellers. Sometimes, funds may use credit swaps to gain exposure to complicated securitized debt markets like commercial mortgage-backed securities.

When bond funds enter into a typical derivative contract (e.g., futures), they need to deposit cash collateral as an initial margin with their brokers. Funds agree to pay to or receive from the broker based on daily fluctuations in the value of derivative positions. Such receipts and payments are called variation margins and are recorded as unrealized gains or losses. If funds fail to provide the variable margin, brokers have the right to close out funds' positions. Once funds close out their derivative positions, they officially record realized gain or loss as the values of derivative positions change at the opening and closing date. The initial and maintenance requirements intend to decrease potential counterparty risks. Such risk is severe for over-the-counter derivative instruments.

3. Data Description

This section describes the data sources, the sample selection procedure, and the construction of crucial derivative measures.

3.1 Data Sources and Sample Selection

This paper extracts mutual fund derivative information from new SEC filings Form N-PORT through the EDGAR system. The Investment Company Reporting Modernization reforms requires mutual funds (except money market funds and small business investment companies) to file the Form N-PORT. Compared to its former counterpart (Form N-Q), it standardizes the disclosure format and contains additional data items such as terms of derivative contracts, information regarding repurchase agreements, funds' securities lending activities, and different portfolio-level risk metrics. Funds in families with net assets of $1 billion must file Form N-PORT from April 30, 2019, while the remaining should start reporting no later than April 30, 2020.[12] Even though funds need to submit filings every month, the public can only access relevant reports at a quarterly frequency. SEC keeps the non-public N-PORT forms for oversight and regulatory purposes.

Form N-PORT contains detailed quarterly derivative holdings. Specifically, I retrieve the following items for every derivative instrument: brief derivative description, market value, portfolio weight relative to a fund's AUM, counterparty information, derivative type, asset type, notional amount, its denominated currency, payoff profile, names of underlying assets, and expiration date. In addition to information on derivative positions, N-PORT filers disclose aggregate realized (unrealized) appreciation or depreciation of derivative positions at the monthly frequency. I employ this information to compute monthly derivative returns. Besides, I also extract general fund information, including fund family name, assigned CIK number, fund name, SEC series number, and reporting date. Appendix A displays an excerpt of derivative information disclosure from A.B. Limited Duration High Income Portfolio based on its Form N-PORT as of December 31, 2019.

[12] Despite the proposed deadline, Kaniel and Wang (2021) reveal that around 89% of mutual funds voluntarily file Form N-PORT in 2019.

The CRSP Survivor-Bias-Free Mutual Fund database provides monthly fund returns, fund flows, securities holdings, and miscellaneous fund characteristics. I obtain a fund-level total net asset (TNA) for funds with multiple share classes by aggregating the TNAs of all share classes (identified by *crsp_cl_grp*). To derive their fund-level counterparts, I value-weight fund net returns and other continuous variables across all share classes. For qualitative attributes, I retain the value of the oldest share class. Following Goldstein et al. (2017), I select corporate bond funds based on their investment objectives reported by CRSP.[13] I delete ETFs and index funds. Finally, I name-match the CRSP sample with N-PORT data.[14] The ultimate sample contains 752 corporate bond funds from 2019 Q3 to 2021 Q4.[15]

I extract corporate bond transaction data from the TRACE and bond characteristics like credit ratings and coupons from the Mergent-FISD database. I exclude asset-backed issues, variable-coupon bonds, bonds that are convertible, puttable, perpetual, exchangeable, and have announced calls, and preferred securities. Since many sample bond funds utilize currency derivatives to either magnify or hedge their exposure to foreign currency, I keep Yankees, Canadian bonds, and bonds denominated in foreign currency or issued globally and group them into foreign holdings. I also collect the World Uncertainty Index (WUI) constructed by Ahir, Bloom, and Furceri (2018).

3.2 Definition of Derivative Variables

[13] A corporate bond fund should have a (1) Lipper objective code of (A, BBB, HY, SII, SID, IID), or (2) Strategic Insight objective code of (CGN, CHQ, CHY, CIM, CMQ, CPR, CSM) or (3) Wiesenberger objective of (CBD, CHY), or 2-digit CRSP objective code of IC.

[14] I manually collect each mutual fund's SEC identifier information (e.g., CIK and SEC series number) based on its name reported in the CRSP database. Then, I employ these identifiers to merge with CRSP sample funds.

[15] In my main analysis that exploits the Covid-19 crisis as a natural experiment, I concentrate on funds that survive at the end of 2019. This filter generates around 600 corporate bond funds.

For some derivative positions with a notional value denominated in foreign currency, I first convert it into a U.S. dollar equivalent through spot rates as of report dates. Then, I sum notional values (absolute asset weight) of all derivative positions to derive fund-level gross notional exposures (total asset weight). I repeat this exercise in each asset type, including interest rate, credit, and currency derivatives.

I adopt two approaches from Kaniel and Wang (2021) to construct derivative return variables. First, I compute derivative return (hereafter, D.R.) as the sum of aggregate realized profit and loss (PnL) and changes in unrealized PnL, normalized by the fund TNA in the preceding month. The non-derivative return (henceforth, non-DR) is the difference between fund net return and derivative return.[16] Second, to gauge the importance of D.R. for a fund, I benchmark D.R. against the non-DR and calculate the relative derivative contribution as the absolute value of the ratio between D.R. and non-DR.[17] Specific formulas are as follows,

$$DR_t = \frac{PnL_t^{Realized} + PnL_t^{Unrealized} - PnL_{t-1}^{Unrealized}}{TNA_{t-1}}$$

$$Derivative\ Relative\ Contribution = |\frac{DR_t}{non - DR_t}|$$

To measure whether funds use derivatives for hedging or speculative purposes, I exploit the relationship between D.R. and non-DR over a specified period. In the primary analysis that exploits the Covid-19 pandemic, for each fund, I first compute the Pearson correlation between D.R. and non-DR from July 2019 to January 2020. The choice of January 2020 ensures that funds' use of derivatives is free of the Covid-19 pandemic.[18] Then, funds with correlations above zero are defined as derivative speculators, while the remaining (below zero) is derivative hedgers. The

[16] The derivative, non-derivative, and fund returns are in the same unit and are comparable.
[17] I use the absolute value to facilitate interpretations by considering that some funds utilize derivatives for hedging motives, and their D.R. could be in the opposite direction from non-D.R.
[18] To address the issue that trivial derivative users may have intermittent derivative returns, I ensure that a fund must have at least five non-zero derivative/non-derivative returns.

classification reveals that derivative speculators tend to employ derivatives to amplify their portfolio exposure to the market. However, derivative hedgers enter into derivative transactions to reduce risk exposures of non-derivative assets.

The anecdotal evidence from the representative sample fund's Form N-CSR as of 2019 Q2 validates this proxy.[19] A hedging fund, the AB FlexFee High-Yield Portfolio managed by AB Bond Fund, Inc-states that

> "The Fund may enter into forward currency exchange contracts in order to hedge its exposure to changes in foreign currency change rates on its foreign portfolio holdings… Because the fund holds fixed-rate bonds, the value of these bonds may decrease if interest rate rise. To help hedge against this risk and maintain its ability to generate income at prevailing market rates, the fund may enter into interest rate swaps…The fund may enter into credit default swap, including to manage its exposure to the market or certain sectors of the market."

In addition to the descriptive evidence, I propose two validity tests based on my detailed derivative return data. First, speculative (hedging) derivative positions usually enhance (decrease) overall portfolio return volatility. According to this intuition, I calculate each fund's total return and non-DR volatility. I expect an average derivative speculator (hedger) to have a positive (negative) difference between the volatility measures.[20] Consistent with the argument, Panel A of

[19] The Form CSR is another SEC filing that requires registered funds to file every six months. Typical items encompass a copy of the report to shareholders, disclosure of auditing information, security holdings, and qualitative disclosure of fund risk factors. For funds that hold derivatives, they may spend some sections discussing risk factors and motives of derivative transactions.

[20] The volatility difference for derivative nonusers is coded as zero.

Table 1 in the Internet Appendix shows that an average derivative speculator (hedger) exhibits positive (negative) volatility differences, suggesting that their derivative positions increase (decrease) overall portfolio return volatility.

Second, I find the speculation/hedge measure exhibits a strong persistence, alleviating a concern that the proxy captures noises rather than the funds' dedicated strategy. Specifically, I divide the entire period into two non-overlapped intervals and then compute each fund's speculation/hedge proxies separately.[21] Panel B of Table 1 in the Internet Appendix indicates that a fund classified as a speculator (hedger) in the first segment is more likely to fall into the same classification in a subsequent period.

4. Descriptive Analysis

This section performs a comprehensive descriptive analysis to shed light on derivative uses by corporate bond funds, including summary statistics of derivative variables and determinants of funds' derivative usage.

4.1 Summary statistics of derivative variables

I first provide summary statistics of crucial derivative variables at the fund and derivative-instrument levels. Table 1 presents that the number of corporate bond funds remains stable at 660 from 2019 Q3 to 2021 Q4. The number of funds using at least a derivative instrument in a given quarter ranges from 355 to 420, accounting for roughly 60% of all sample funds. Figure 1 also displays a stable trend for funds' use of derivatives during my sample period. Specific to each

[21] The first period begins from July 2019 to December 2020, and the second spans from January 2021 to December 2021.

derivative category, I find that interest rate derivatives dominate among all derivative instruments. At least 80% of derivative funds utilize interest rate derivatives to exploit interest rate fluctuations.

Panel A of Table 2 displays summary statistics at the derivative contract level. Corporate bond funds generally utilize five derivative instruments: forward, future, swap, swaption, and option. Swap contracts (40.5%) represent the most common derivative type, while options or swaption only account for 8%. Analogous to Table 1, interest rate derivatives still play a dominant role, meaning that interest rate fluctuations pose a leading threat to corporate bond funds. The average derivative weight relative to funds' TNA (median) is merely 0.08% (0.002%), whereas the average notional amount of a derivative contract is 1.14% in terms of funds' TNA (0.56%).[22] Such a large discrepancy reveals a substantial leverage risk born by derivative users. The average time to maturity as of the fund reporting dates ranges from 0.131 years to 4.794 years,[23] implying that some exchanged-traded derivatives are liquid and can be frequently rolled over. However, some illiquid over-the-counter derivatives might create long-lasting obligations.

Panel B of Table 2 summarizes derivative variables at the fund-quarter level. The average (median) number of derivative positions is 23.64 (3) in a fund quarter. Even though the total derivative asset weight for an average fund is around 2% of its TNA, the corresponding gross notional amount accounts for about 32% of the TNA. The discrepancy re-corroborates that derivative users bear excessive leverage risks and may suffer enormous payment obligations during market turmoil. Figures 2 show that the variables of gross notional exposure and total derivative weights are highly right-skewed, indicating the existence of heavily leveraged derivative funds which can control a large amount of securities value through light-weighted

[22] Table 2 shows that the mean (median) notional amount of individual derivative position is $32.67 million ($3 million), and the mean (median) fund net assets are $2859.35 million ($532.75 million).
[23] The range is between first and third quartiles.

derivative positions. Concretely, although Panel (a) of Figure 3 shows that a typical heavy derivative user spends only 5% of its TNA on derivative positions, their gross notional value is equivalent to 100% of that Fund's TNA in Panel (a) of Figure 2. Analyzing the exposure of each asset category generates similar information.

Panel C of Table 2 reports derivative return information at the fund-month level. The average monthly D.R. (non-DR) is about 0.022% (0.323%), with a standard deviation of 0.723% (1.975%). Trivial derivative funds pollute the aggregate statistics and disguise the importance of D.R. in total fund return. A fatty-tail distribution of D.R. shown in Panel (a) of Figure 4 accentuates that a subset of heavy derivative users tremendously gains or loses from their derivative positions, with a D.R. of more than 3%. Panel (c) of Figure 4 also confirms this argument by showing that roughly 20% of funds' D.R., in absolute magnitude, is at least equal to their non-DR.

Figure 4 plots the correlation between D.R. and non-DR before the Covid-19 crisis and over the sample period. There exists a heterogeneous use of derivatives amid corporate bond funds. Contrary to the narrative that derivative positions mainly serve the hedging purpose (Koski and Pontiff, 1999), some bond funds exploit the unique characteristics of derivative instruments to boost their portfolio risk exposures and increase returns (Aragon et al., 2019; Jiang et al., 2020; Kaniel and Wang, 2021). By estimating the return correlation over the whole sample period, Panel (a) shows that around 40% of derivative funds have a positive correlation, and 7% have a return correlation exceeding 0.5. Approximately 60% of derivative users have a negative return correlation, and 10% of derivative funds heavily (correlation greater than 0.5) hedge their non-derivative positions.

4.2 Determinant of derivative usage

I examine the factors associated with a bond fund's decision to utilize derivatives. Concretely, I regress funds' derivative exposure on various fund characteristics, with the control of fund-objective/time fixed effects,

$$Derivative\ Exposure_{i,t} = \gamma \times X_{i.t-1} + \mu_{fund-objective} + \mu_t + \varepsilon_{i,j}, \quad (1)$$

where $Derivative\ Exposure_{i,t}$ denotes derivative variables of a fund i in year-quarter t, including log (gross notional exposure) and indicators for speculators/hedgers.[24] $X_{i.t-1}$ captures lagged fund attributes: log (fund TNA), log (fund age), cash holding, fund maturity, past fund return volatility, the fraction of institutional shares, interest rate risk, credit risk, and global uncertainty beta. All the specifications contain fund-objective fixed effects and year-quarter fixed effects. Standard errors are clustered at the fund and year-quarter levels.

The derivative usage by bond funds rests on several motives. First, fund managers can benefit from derivatives' low-trading-cost features to achieve optimal risk exposure (Deli and Varma, 2002). To alter their portfolio risk exposures, bond funds must withstand nontrivial transaction costs through trading illiquid corporate bonds (Bao, Pan, and Wang, 2011). Nevertheless, actively traded CDS markets allow fund managers to easily buy or sell CDS investments to adjust credit risk exposure without bearing significant trading costs (Ohemke and Zawadowski, 2015). Likewise, relatively liquid markets for interest rate derivatives also allow bond funds to enter into a fixed-to-float swap or short Treasury futures to reach their duration targets. Therefore, I anticipate that funds with demand for derivatives' low-trading-cost traits are inclined to engage in relevant derivative transactions.

[24] In this specification, I estimate correlations between derivative and non-derivative returns each quarter using the past 2-quarter observations (including the current quarter; six monthly observations). To deal with trivial derivative users, I ensure that a fund must have at least five non-zero derivative/non-derivative returns in a rolling window.

I capture fund demand for the trading-cost benefits by using three characteristics: fund TNA, cash holdings, and fund maturity. The logic is that large funds possess sufficient expertise in using derivative instruments and thus benefit from economies of scale (Koski and Pontiff, 1999). Because trading by larger funds generally induces a greater price impact, they gravitate toward relatively liquid equivalents to mitigate transaction costs. Cash-rich funds benefit less from derivative positions in that cash reserves serve as indispensable liquidity management tools for bond funds to deal with adverse events such as excessive investor redemptions or the significant price impact externalities of bond trading (Morris et al., 2017; Cherenko and Sunderam, 2020; Jiang et al., 2021). Since fluctuations in interest rates significantly influence bond funds' portfolio value, funds with prolonged maturities tend to exploit relatively liquid interest rate derivatives rather than trade illiquid corporate bonds.

Table 4 reports the empirical results. All the columns show that fund TNA positively relates to gross derivative exposure and propensity for speculation/hedging, suggesting that large funds possess the expertise to tap into liquid derivative markets, thereby alleviating price impacts of trading illiquid securities directly. Such a notion applies to the derivative usage for speculative and hedging motives. In Column 1, a negative coefficient on cash holdings suggests that cash buffers can be a substitute for derivatives to help fund managers address adverse events like investor withdrawals. Column 3 indicates that this finding primarily comes from bond funds using derivative instruments for hedging purposes. Finally, a positive relationship between fund maturity and gross derivative exposure in Column 1 reveals that bond funds sensitive to interest rate fluctuations resort to relatively liquid interest rate derivatives to modify the portfolio duration. When decomposing the derivative exposures used for speculative and hedging motives in Columns

2 & 3, I find that funds with longer maturities are more likely to own hedging interest rate derivatives to guard against volatile interest rate changes.

Second, derivative contracts enable fund managers to exploit investment opportunities in inaccessible asset classes (e.g., foreign currency or securitized debts) and circumvent the short-selling constraints (Sorescu, 2000). Meanwhile, derivative instruments help funds leverage their market exposure with small capital outlays. Therefore, I expect risk-tolerant funds tend to utilize derivatives for speculative purposes. Consistent with this prediction, Column 2 of Table 4 displays a positive coefficient on fund return volatility, indicating that risk-tolerant funds (measured by high fund return volatility) are more likely to exploit the flexibility of derivative contracts to bet on fluctuating market conditions.

Third, funds' client base can determine their incentives for employing derivative instruments. Because institutional investors are assumed to be sophisticated and possess internal risk management tools, they can hedge against possible risk factors by themselves rather than rely on their mutual fund managers (Sialm and Zhu, 2021). Thus, I hypothesize that bond funds that predominantly serve retail clients prefer to utilize hedging derivative positions. Column 1 of Table 4 bolsters this conjecture: the fraction of institutional shares is negatively associated with the derivative exposure. When I separately examine the derivative usage for speculative and hedging purposes in Columns 2 & 3, I find that institutional clients prefer to utilize funds' derivative speculation services, possibly due to their internal risk management tools. This result corroborates the finding of Sialm and Zhu (2021) that retail clienteles may not possess efficacious risk management tools and call for such services from their mutual fund managers.

Ultimately, bond funds susceptible to common bond risk factors require pertinent derivative instruments to lower the overall portfolio risk exposures. For example, funds that hold long-term fixed-rate bonds are sensitive to interest rate changes, thus demanding appropriate interest rate derivatives such as Treasury futures and interest rate swaps. Funds with high exposure to high-yield bonds suffer from credit market risk and might purchase credit protections in CDS markets (Jiang, Ou, and Zhu, 2021). Funds' foreign holdings are subject to foreign currency risks and global economic uncertainty. In this situation, fund managers may sell foreign currency forwards to lower their portfolio exposure to currency risk (Sialm and Zhu, 2021). Hence, I predict bond funds sensitive to these risk factors tend to employ suitable derivative contracts to manage the risk profile.

I measure funds' interest rate, credit, and foreign currency risks by the portfolio value change of a 1-basis-point change in interest rates (DV 01), the portfolio value change of a 1-basis-point change in credit spread (SDV 01), and the fund beta of the World Uncertainty Index (WUI). Consistent with my hypotheses, Column 1 of Table 4 presents that funds sensitive to interest rate and foreign currency risks enhance their derivative exposures. Columns 2 & 3 indicate that these funds curb their speculative activities and attempt to use appropriate derivative instruments to protect against corresponding risk factors. A negative coefficient on SDV 01 in Columns 1 & 3 is surprising since funds with high credit risks should hold hedging credit derivatives (e.g., CDS protection) and deliver high derivative exposure. However, the negative sign of coefficient on SDV 01 in Column 2 kindly suggests that bond funds already exposed to adequate credit risk prefer to decrease their speculations in credit derivatives (e.g., sell CDS protection).

5. Impact of derivative usage on bond liquidation

In this section, I investigate whether corporate bond funds' derivative usage affects their bond liquidations during market turmoil. First, I compare bond selling activities of derivative speculators/hedgers to derivative nonusers. Then, I conduct cross-sectional tests to demonstrate that specific bond/fund attributes could influence forced liquidations of derivative funds.

5.1 Baseline Results

As described in the institutional background, derivatives render bond funds susceptible to exotic risks as opposed to traditional investments. For instance, funds can gain exposure to risky inaccessible markets such as foreign currency or securitized debt products. Counterparties may also default on their obligations, which incurs a loss to derivative funds. Amid these risk factors, however, the leverage risk should be the predominant one because derivative contracts allow funds to gain or lose on a notional amount substantially surpassing their initial investments. The summary statistics in Table 2 reveal that although an average bond fund's total derivative weight only accounts for about 2% of its TNA, its derivative positions' notional values can be close to 32%. If market conditions move in the opposite direction, leveraged derivative positions will obligate funds to make excessive cash payments or deliver equivalent physical assets to the counterparties.

Derivative speculators appear vulnerable to leverage risks since they use derivatives to amplify market exposures or speculate on fluctuations in risky asset classes. The leveraged derivative positions can thus trigger enormous losses and payment obligations following adverse shocks. In the spirit of Brunnermeier and Pedersen (2009), if funds lack adequate liquid reserves to satisfy margin requirements, they must fire-sell non-derivative holdings. On the contrary, derivative hedgers that lessen their exposure to risky assets via derivative instruments can hedge their portfolios against adverse market movements, curtailing their fire-sale activities. I hypothesize that derivative speculators (hedgers) are more (less) likely to unwind non-derivative positions relative to derivative nonusers during market stress.

I exploit the Covid-19 crisis as a plausibly exogenous negative shock to examine the liquidation behavior of derivative speculators and hedgers during uncertain periods. The Covid-19 pandemic setting is ideal for this test. The virus-initiated crisis rapidly generates a widespread liquidity crunch triggering a substantial loss for funds' speculative derivative positions. Bond funds also need to grapple with mounting investor redemptions, depleting their liquid cushions that can be used to pay off obligations for derivative positions. Specifically, I perform a cross-sectional regression at the bond-fund level by regressing liquidations of bond i by fund j on dummies for speculators and hedgers.

$$Bond\ Liquidation_{i,j} = \beta_1 \times Speculator_j + \beta_2 \times Hedger_j + \gamma \times X_j + \mu_{bond} + \mu_{issuer} + \mu_{rating} + \mu_{industry} + \mu_{fund\_objective} + \varepsilon_{i,j}, \quad (2)$$

where $Bond\ Liquidation_{i,j}$ denotes the negative quantity change in bond i by fund j from Q4 2019 to Q1 2021. $Speculator_j$ ($Hedger_j$) equals an indicator for derivative speculators (hedgers).[25] Since I exclude the dummy for derivative nonusers, β_1 (β_2) captures bond liquidations of derivative speculators (hedgers) relative to derivative nonusers. A positive (negative) β_1 (β_2) implies derivative speculators liquidate more (less) bond holdings than derivative nonusers.

I add a host of fund-level controls (X_j) as of 2019 Q4, including log (fund TNA), log (fund age), 12-month style-adjusted fund return, fund return volatility, cash holding, contemporaneous quarterly fund flows, fund illiquidity based on the Amihud ratio of held bonds, and fund maturity. Previous literature underscores that mutual funds engage in forced flow-driven trading in response to investor redemptions (Coval and Stafford, 2007; Jiang et al., 2021; Ma et al., 2022). By controlling for contemporaneous fund flows and prior fund performance, I can interpret my results

[25] The classification is based on observations before the Covid-19 crisis.

as bond liquidations incremental to the impacts of investor withdrawals. I also control bond fixed effects, bond issuer fixed effects, bond rating fixed effects, bond issuer industry fixed effects, and fund objective fixed effects. Standard errors are clustered at the bond issuer level.

Table 5 reports empirical results. First, Column 1 shows that the coefficient on the speculator dummy is significantly positive, consistent with the conjecture that derivative speculators tend to fire-sell their bond holdings to meet payment obligations of leveraged derivative positions. Second, the negative coefficient on the hedger indicator illustrates that since derivative hedgers use derivative positions to safeguard against adverse effects of market movements, they are less likely to liquidate bond holdings than derivative nonusers. The comparison test ($\beta_1 = \beta_2$) also indicates that coefficients on the two indicators are statistically different at a 1% level. Column 2 of Table 5 shows that the baseline results survive after adding contemporaneous fund flows and other fund-level controls, suggesting that the liquidation results are incremental to the effect of investor redemptions. The economic magnitudes for both dummies are sizeable: compared to derivative nonusers, derivative speculators (hedgers) decrease (increase) their bond holdings by 1.078% (1.136%). Given that the mean bond liquidation is 16%, the 1.078% increase (1.136% decrease) represents 6.74% (7.10%) of the sample average.

Coefficients on control variables echo the findings in the preceding literature. For example, a positive sign on contemporaneous fund flows highlights that fund outflows induce funds to scale down their bond holdings to meet investor redemptions (Jiang et al., 2021; Ma et al., 2022). Regarding economic magnitude, a standard deviation increase in contemporaneous fund flows reduces bond liquidations by 4.19% (15.124×0.277), which is about four times as large as the magnitudes of speculator/hedger indicators.

The negative coefficient of the cash holding variable highlights the importance of a cash buffer as a liquidity management tool to lower the likelihood of fire-selling during economic downturns (Chernenko and Sunderam, 2020). The economic magnitude is comparable to that of the speculator/hedger dummy: a standard deviation increase in cash holdings leads to a 0.505% (9.909×0.051) decrease in bond liquidations. This finding reflects the stated assertion of Release 10666 mentioned in the institutional background: Segregating liquid cushions can somewhat offset the possible loss of speculative derivative positions.

To summarize, substantial leverage risks of derivative instruments render bond funds subject to huge losses and payment obligations during market turbulence. To meet these debt obligations, speculative funds switch to fire-sell non-derivative securities if they lack liquid buffers. Derivative hedgers can mitigate losses of non-derivative assets through the gains from their hedging positions.

5.2 Heterogenous Liquidations across Individual Bonds

The baseline test has demonstrated that derivative speculators, compared to derivative nonusers and derivative hedgers, are more inclined to fire-sell non-derivative holdings to satisfy the margin requirements of their leveraged derivative positions during market stress. I now investigate whether derivative users' liquidation depends on the bond liquidity. The theory implies that fund managers adopt a "liquidity pecking order" to eschew costly liquidations by selling liquid corporate bonds first (Scholes, 2000; Ma et al., 2022). This liquidation strategy could enable fund managers to not only smooth out the negative impact of investor withdrawals but also earn risk premiums of illiquid assets (Pastor and Stambaugh, 2003). Nevertheless, the rising likelihood of margin calls and risk management considerations compel asset managers with funding constraints to decrease exposure to illiquid assets during market stress (Vayanos, 2004; Brunnermeier and Pedersen, 2009). Hence, which effect dominates is an empirical question.

To test the hypothesis above, I measure bonds' liquidity risk by return volatility and Amihud's (2002) illiquidity ratio in 2019 Q4.[26] Then, I partition it into two subsamples based on the median of each variable and estimate the equation (1) separately. In Panel A of Table 6, using Amihud's (2002) illiquidity ratio as a proxy, Columns 1 and 2 indicate that derivative speculators primarily unwind liquid corporate bonds to satisfy their payment obligations of derivative positions. This result resonates with the theory that in response to margin calls from derivative positions, derivative speculators sell liquid assets to evade short-term liquidation costs. Interestingly, derivative hedgers mainly lower their sale of illiquid positions, reinforcing that compensations from derivative hedging positions allow bond funds to offset the current losses of illiquid securities and capture liquidity premiums later. Columns 3 and 4 generate similar results based on the bond return volatility.

5.3 Heterogenous Liquidations across funds

I conduct additional cross-sectional tests to evaluate whether heterogenous derivative funds have different liquidation behavior. First, derivative speculators with greater exposure should suffer more losses and bear more payment obligations during market uncertainty. This case works oppositely for derivative hedgers because their heavy hedging positions help offset the loss from their non-derivative securities. Thus, I expect heavy derivative speculators to fire-sell more non-derivative assets to meet losses of their leveraged derivative positions. In contrast, heavy derivative hedgers earn massive gains from hedging positions, diminishing the likelihood of forced liquidations.

[26] I calculate the two variables using daily bond observations in 2019 Q4

Second, my baseline specification assumes that when an economic downturn triggers excessive payment obligations for derivative speculators, these funds with insufficient liquid reserves must fire-sell illiquid bonds to meet their obligations. Hence, I hypothesize that derivative speculators short of liquid cushions tend to unwind more non-derivative holdings than derivative nonusers. Meanwhile, the lack of liquid buffers can also hurt derivative hedgers since these liquid holdings serve as fundamental liquidity management tools to curb forced fire-sale (Morris et al., 2017; Chernenko and Sunderam, 2020; Jiang et al., 2021;).

To test these conjectures, I capture a fund's derivative exposure via the relative contribution of its derivative return and gross notional exposure. I proxy a fund's liquidity reserve by its cash holding and portfolio illiquidity. Then, I estimate the following regression,

$$\begin{aligned} Bond\ Liquidation_{i,j} = {} & \beta_1 \times\ Speculator_j \times LowChar_j + \beta_2 \times\ Speculator_j \times HighChar_j \\ & + \beta_3 \times Hedger_j \times LowChar_j + \beta_4 \times\ Hedger_j \times HighChar_j + \gamma \times\ X_j \\ & + \mu_{bond} + \mu_{issuer} + \mu_{rating} + \mu_{industry\ j} + \mu_{fund\_objective} + \varepsilon_{i,j}, \end{aligned} \tag{3}$$

where $LowChar_j$ and $HighChar_j$ measure the above fund attributes: relative return contribution, gross notional exposure, cash holding, and fund illiquidity.[27] Specifically, $LowChar_j$ ($HighChar_j$) represents an indicator that equals one if a fund's characteristic is below (above) the median. All other variables are the same as those in equation (1). Standard errors are clustered at the bond issuer level.

Analogous to equation (2), derivative nonusers still serve as benchmark groups. In Panel B of Table 6, Column 1 shows the results based on relative return contribution. The coefficient for speculator (hedger) dummy interacted with an indicator of high return contribution is positively (negatively) significant. In contrast, interaction terms with a low return contribution indicator

[27] The four variables are measured as of 2019 Q4.

(speculator or hedger) either lose their statistical significance or produce conflicting signs. These results bolster the hypothesis that derivative speculators with heavy exposures try to liquidate non-derivative assets to satisfy their tremendous loss from their speculative derivative positions. However, derivative hedgers can alleviate loss from non-derivative securities via compensations from their hedging derivative positions, decreasing the probability of forced liquidations. Column 2 shows similar findings if I proxy funds' derivative exposure by the gross notional exposure.

Using the fund illiquidity, Column 3 of Table 4 displays a significantly positive coefficient for the interaction term between the speculation dummy and the indicator of high fund illiquidity. This finding suggests that derivative speculators with inadequate liquid buffers must scale down non-derivative assets to meet their vast loss from their speculative derivative positions. An insignificant coefficient on the interaction term for illiquid hedgers also emphasizes the importance of liquid holdings against forced liquidations during market turmoil. Column 4 generates the same results based on the cash holding.

6. Asset Pricing Implications of Derivative Usage

So far, I have demonstrated that compared to derivative nonusers and derivative hedgers, derivative speculators tend to liquidate bond holdings to satisfy the payment obligations of their speculative derivative positions. In this section, I investigate whether derivative speculators' fire-sell behavior depresses the prices of underlying bonds and enhances bond return volatility.

6.1 Bond return dynamics

The excessive liquidations by derivative speculators exert substantial price pressures on corporate bond markets (Coval and Stafford, 2007; Cai et al., 2019; Ma et al., 2022). In such a situation, a loss spiral arises because the initial price depressions can exacerbate derivative speculators' losses, thus inducing more liquidations and causing a further price drop (Brunnermeier and Pedersen, 2009).

I construct bond-level exposure to derivative speculators' fire-sales as the difference between ownership of derivative speculators and ownership of derivative hedgers at the end of 2019 (net ownership hereafter). The intuition of this ownership measure depends on empirical results in the previous sections. Recall that compared to derivative nonusers, derivative speculators subject to severe leverage risks resort to liquidating non-derivative securities to meet the debt obligations of their speculative positions. The opposite occurs for derivative hedgers who gain from their hedging derivative positions and thus alleviate the loss of non-derivative assets. The net ownership variable combines the offsetting effects of two separate ownership variables. Therefore, I anticipate that bonds heavily held by derivative speculators (hedgers) will experience high (low) selling pressure.

I initially perform a univariate test by sorting all corporate bonds based on their net speculators' ownership into quartiles. Bonds in the top quartile (quartile 4) are primarily held by derivative speculators as of 2019 Q4, whereas derivative hedgers heavily hold bonds in the lowest quartile (quartile 1). Figure 6 shows the dynamics of daily returns for the two groups from January 1, 2020 to April 30, 2020. Before the Covid-19 crisis began, there were no apparent return differences between the two bond portfolios. However, once the crisis starts, bonds mostly held by derivative speculators exhibit more substantial price declines than peers primarily held by derivative hedgers. After the Federal Reserve's interventions (March 23, 2020), bonds with high exposure to derivative speculators experience larger price rebounds than their low-exposure counterparts. This result indicates that the price drop during the crisis arises from bond-level selling pressure from their mutual fund holders instead of bond issuers' fundamentals.

To further address the issue that results from the univariate analysis may stem from the effects of unobserved bond characteristics during the Covid-19 crisis, I construct a bond-day sample spanning January 1, 2020, to March 23, 2020, and estimate the following difference-in-difference regression.

$$Return_{i,t} = \beta \times Net\ Owernship_i \times Crisis_t + \alpha \times Derivative\ nonuser\ Owernship_i \times Crisis_t + \gamma \times X_{i.t} + \mu_{bond} + \mu_{issuer,t} + \mu_{rating,t} + \mu_{industry,t} + \varepsilon_{i,j}, \quad (4)$$

$Return_{i,t}$ refers to the bond return of bond i at day t; $Net\ Speculator\ Owernship_i$ is the difference between ownership of derivative speculators and ownership of derivative hedgers at the end of 2019; and $Crisis_t$ represents the indicator equal to 1 after March 6, 2020. Since prior literature highlights that selling pressure from general bond funds can depress asset prices, I also include the interaction between derivative nonuser ownership and $Crisis_t$ (Jiang et al., 2021; Ma et al., 2022).

The time-varying bond-level controls include log (bond age), log (number of months to maturity), and log (daily trading volume). I also include bond fixed effects, bond-issuer-day fixed effects, bond-rating-day fixed effects, and bond-issuer-industry-day fixed effects. $Net\ Speculator\ Owernship$ and $Crisis_t$ are subsumed by these fixed effects. Rich fixed effects can mitigate concerns that unobserved time-varying bond-issuer attributes confound my empirical findings (Choi, Hoseinzade, Shin, and Tehranian, 2020). In particular, the main coefficient β captures the price impact of two similar bonds with the same issuer, rating, and issuer industry, but with different ownership of derivative speculators. Standard errors are clustered at the bond and date levels.

Consistent with the univariate analysis, Column 1 of Table 7 shows that corporate bonds primarily held by derivative speculators experienced a price decline during the crisis. Column 2 shows that the return effect is robust to including time-varying bond-level controls. The economic magnitude appears sizable: in the most restrictive specification in column 2, a one-standard-deviation increase in net speculators' ownership reduces daily bond returns by 10.08 basis points ($0.494 \times$ 0.203=0.1002%), equivalent to 13% of median-level daily bond returns across all bonds during the Covid-19 crisis. Interestingly, after controlling for the impact of net speculator ownership, the coefficient on interaction term for derivative nonuser ownership loses statistical significance, suggesting that price depression due to bond funds' selling pressuring could mainly arise from the influence of derivative speculators.

I estimate an analogous regression in equation (5) in post-crisis periods (from March 1, 2020, to April 30, 2020) to explore the impact of funds' derivative speculation on price reversals.

$$Return_{i,t} = \beta \times Net\ Owernship_i \times Recover_t + \alpha \times Derivative\ nonuser\ Owernship_i \times Recover_t + \gamma \times X_{i.t} + \mu_{bond} + \mu_{issuer,t} + \mu_{rating,t} + \mu_{industry,t} + \varepsilon_{i,j}, \quad (5)$$

$Recover_t$ denotes the dummy equal to 1 after March 23, 2020. Other variables and fixed effects are the same as in equation (4). Standard errors are also clustered at the bond and date levels.

Column 3 of Table 5 shows that bonds primarily held by derivative speculators exhibit more significant price rebounds than those mainly held by derivative hedgers. Column 4 indicates that the main finding remains almost intact after controlling for time-varying bond characteristics. Using estimates from Column 4, a one-standard-deviation- increase in net speculators' ownership raises a bond's daily return by 10.71 basis points (0.494 0.217=0.1071%), which is economically meaningful given that the median and standard deviation of post-crisis returns are 0.189% and 2.249%, respectively.

6.2 Bond return volatility

Previous sections have shown that bonds primarily owned by derivative speculators are more exposed to leverage-induced selling pressure and should exhibit more non-fundamental volatility (Greenwood and Thesmar, 2011). This case applies to the crisis and post-crisis periods as Figure 3 indicates that bonds with considerable exposure to derivative speculators exhibit dramatic price moves in both periods. In this subsection, I aim to estimate the economic magnitudes of these non-fundamental risks by testing whether bonds heavily held by derivative speculators manifest higher return volatility during and after the Covid-19 pandemic.

To do that, I run the following difference-in-difference regression from January 2020 to April 2020.

$$\begin{aligned} Return\ Volatility_{i,t} &= \beta_1 \times Net\ Owernship_i \times Crisis_t + \beta_2 \times Net\ Owernship_i \times Recover_t \\ &+ \alpha_1 \times Derivative\ nonuser\ Owernship_i \times Crisis_t + \alpha_2 \times Derivative\ nonuser\ Owernship_i \times Recover_t \\ &+ \gamma \times X_{i.t} + \mu_{bond} + \mu_{issuer,t} + \mu_{rating,t} + \mu_{industry,t} + \varepsilon_{i,j}, \end{aligned} \tag{6}$$

$Return\ Volatility_{i,t}$ represents realized bond volatility of bond i in month t, measured by the standard deviation of daily bond returns over a month; $Net\ Speculator\ Owernship_i$ denotes the difference between ownership of derivative speculators and ownership of derivative hedgers as of 2019 Q4; and $Crisis_t$ ($Recover_t$) is the dummy equal to 1 for March 2020 (April 2020). I also control for the impact of derivative nonuser ownership. The bond-level controls contain log (bond age), log (time to maturity), and log (total trading volume). I also add rich fixed effects to address issues that time-varying bond issuer characteristics might drive my results. Standard errors are clustered at the bond and year-month levels.

In Column 1 of Table 8, a significantly positive β_1 substantiates the claim that bonds exposed to derivative speculations exhibit excess return volatility relative to their low-exposure counterparts during the crisis. The bond volatility stays elevated in the post-pandemic periods, evidenced by positive β_2. Column 2 shows that the baseline findings remain unchanged after adding additional time-varying bond-level controls. The economic magnitude is nontrivial: a one-standard-deviation increase in net speculators' ownership leads to an increase of 0.117% (0.041%) in the monthly bond return volatility during the Covid-19 crisis (post-crisis), equivalent to 9.5% (0.03%) of its sample mean.

Bond return dynamics and volatility collectively demonstrate that funds' speculative derivative transactions can destabilize underlying bond markets by imposing substantial losses for these funds and forcing them to liquidate bond holdings to meet payment obligations. Nonetheless, funds' hedging positions can alleviate loss from their non-derivative holdings, reducing the probability of funds' forced liquidations and curtailing subsequent disruptive effects on bond markets.

7. Conclusion

Derivative usage has become widespread in the mutual fund industry. Fund managers not only engage in derivative transactions to safeguard against unfavorable market conditions but also exploit derivatives' unique characteristics to speculate on risky asset classes and leverage market exposures. Such speculative activities introduce substantial fragility risks to financial markets. By using detailed derivative information from Form N-PORT, I investigate how derivative speculations of mutual funds strain financial markets.

I test this research question in the corporate bond fund setting as its illiquid asset holdings exacerbate adverse consequences of mutual funds' liquidity transformation on financial market fragility (Goldstein et al., 2017). I uncover that bond funds using derivatives for speculative purposes unwind more non-derivative securities than derivative nonusers, particularly for funds with considerable derivative exposure and tight liquid buffers. This finding supports the notion that since speculative derivative positions bring about severe leverage risks for bond funds during market stress, derivative speculators must unwind non-derivative holdings to pay off corresponding obligations if they are short of liquid reserves. On the other hand, I also document that derivative hedgers engage in fewer unwanted liquidations as the gains from their hedging derivative positions can effectively counteract the losses of their non-derivative assets. More importantly, excessive liquidations by derivative speculators add significant selling pressure on held bonds, thereby leading to asset price drops and excess return volatility.

My findings have implications for recent regulations on mutual funds' derivative usage (Rule 18f-4). The new rule rescinds the original loose framework that could introduce investor protection concerns about mutual funds' derivatives use. Instead, derivative funds should implement a risk management program that routinely monitors funds' risk-taking behavior via derivative instruments and comply with an outer VaR limit to alleviate the destabilizing effects of excessive leverage. My paper shows that mutual funds utilize derivatives for heterogeneous purposes, and various derivative usage can generate distinct impacts on financial market stability. Hence, disclosing specific derivative exposure for speculation and hedging can improve investor welfare and facilitate regulatory oversight. Moreover, my analysis indicates that the leverage risk is the primary channel through which mutual funds' derivative uses disrupt financial markets. Regulators may adopt more effective leverage risk metrics to monitor funds' leverage usage via derivative instruments.

References

Ahir, H., Bloom, N., and Furceri, D., 2022. The world uncertainty index. National Bureau of Economic Research.

Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. *Journal of financial markets* 5: 31-56.

Anand, A., Jotikasthira, C., and Venkataraman, K. 2021. Mutual fund trading style and bond market fragility. *The Review of Financial Studies* 34:2993-3044.

Aragon, G.O., and Li, L., 2019. The use of credit default swaps by bond mutual funds: Liquidity provision and counterparty risk. *Journal of Financial Economics* 131:168-185.

Aragon, G.O., and Martin, J.S., 2012. A unique view of hedge fund derivatives usage: Safeguard or speculation?. *Journal of Financial Economics* 105:436-456.

Aragon, G.O., Martin, J.S., and Shi, Z., 2019. Who benefits in a crisis? Evidence from hedge fund stock and option holdings. *Journal of Financial Economics* 131:345-361.

Aragon, G.O., and Strahan, P.E., 2012. Hedge funds as liquidity providers: Evidence from the Lehman bankruptcy. *Journal of Financial Economics* 103:570-587.

Bao, J., Pan, J., and Wang, J. 2011. The illiquidity of corporate bonds. *The Journal of Finance* 66:911-946.

Brunnermeier, M.K., and Pedersen, L.H., 2009. Market liquidity and funding liquidity. *The Review of Financial Studies* 22:2201-2238.

Cai, F., Han, S., Li, D., and Li, Y., 2019. Institutional herding and its price impact: Evidence from the corporate bond market. *Journal of Financial Economics* 131:139-167.

Cella, C., Ellul, A., and Giannetti, M., 2013. Investors' horizons and the amplification of market shocks. *The Review of Financial Studies* 26:1607-1648.

Chen, Y., 2011. Derivatives use and risk taking: Evidence from the hedge fund industry. *Journal of Financial and Quantitative analysis* 46: 1073-1106.

Chen, Q., Goldstein, I., and Jiang, W., 2010. Payoff complementarities and financial fragility: Evidence from mutual fund outflows. *Journal of Financial Economics* 97:239-262.

Chernenko, S. and Sunderam, A., 2020. Do fire sales create externalities?. *Journal of Financial Economics* 135:602-628.

Choi, J., Hoseinzade, S., Shin, S.S. and Tehranian, H., 2020. Corporate bond mutual funds and asset fire sales. *Journal of Financial Economics* 138: 432-457.

Greenwood, R., and Thesmar, D., 2011. Stock price fragility. *Journal of Financial Economics* 102:471-490.

Coval, J., and Stafford, E., 2007. Asset fire sales (and purchases) in equity markets. *Journal of Financial Economics* 86:479-512.

Deli, D.N., and Varma, R., 2002. Contracting in the investment management industry: evidence from mutual funds. *Journal of Financial Economics* 63:79-98.

Diamond, D.W., and Dybvig, P.H., 1983. Bank runs, deposit insurance, and liquidity. *Journal of Political Economy* 91:401-419.

Fabozzi, F.J. and Mann, S.V., 2012. The Handbook of fixed income securities. McGraw-Hill Education.

Falato, A., Goldstein, I., and Hortaçsu, A., 2021. Financial fragility in the COVID-19 crisis: The case of investment funds in corporate bond markets. *Journal of Monetary Economics* 123:35-52.

Goldstein, I., Jiang, H., and Ng, D.T., 2017. Investor flows and fragility in corporate bond funds. *Journal of Financial Economics* 126:592-613.

Jiang, H., Li, Y., Sun, Z., and Wang, A., 2022. Does mutual fund illiquidity introduce fragility into asset prices? Evidence from the corporate bond market. *Journal of Financial Economics* 143:277-302.

Jiang, H., Li, D., and Wang, A., 2021. Dynamic liquidity management by corporate bond mutual funds. *Journal of Financial and Quantitative Analysis* 56:1622-1652.

Jiang, W., Ou, J., and Zhu, Z., 2021. Mutual fund holdings of credit default swaps: Liquidity, yield, and risk. *The Journal of Finance* 76:537-586.

Kaniel, R., and Wang, P., 2020. Unmasking Mutual Fund Derivative Use. Working Paper.

Koski, J.L., and Pontiff, J., 1999. How are derivatives used? Evidence from the mutual fund industry. *The Journal of Finance* 54:791-816.

Li, Y., O'Hara, M., and Zhou, X.A., 2021. Mutual fund fragility, dealer liquidity provisions, and the pricing of municipal bonds. Working Paper.

Ma, Y., Xiao, K., and Zeng, Y., 2022. Mutual fund liquidity transformation and reverse flight to liquidity. *The Review of Financial Studies forthcoming*.

Morris, S., Shim, I., and Shin, H.S., 2017. Redemption risk and cash hoarding by asset managers. *Journal of Monetary Economics* 89:71-87.

Oehmke, M. and Zawadowski, A., 2015. Synthetic or real? The equilibrium effects of credit default swaps on bond markets. *The Review of Financial Studies 28*:3303-3337.

Pástor, Ľ. and Stambaugh, R.F., 2003. Liquidity risk and expected stock returns. *Journal of Political Economy* 111: 642-685.

Scholes, M.S., 2000. Crisis and risk management. *American Economic Review* 90:17-21.

Sialm, C., and Zhu, Q., 2021. Currency management by international fixed income mutual funds. National Bureau of Economic Research.

Sorescu, S.M., 2000. The effect of options on stock prices: 1973 to 1995. *The Journal of Finance 55*:487-514.

Vayanos, D., 2004. Flight to quality, flight to liquidity, and the pricing of risk, MIT Working Paper.

Appendix A: Example of Derivative Holding Disclosure

This appendix provides partial information about a credit default swap position of A.B. Limited Duration High Income Portfolio from A.B. Bond Fund Inc., extracted from its Form N-PORT as of December 31, 2020.

Item C.1. Identification of investment.	
a. Name of issuer (if any).	Goldman Sachs International
b. LEI (if any) of issuer. In the case of a holding in a fund that is a series of a series trust, report the LEI of the series.	W22LROWP2IHZNBB6K528
c. Title of the issue or description of the investment.	Long: IS1RMP7 CDS USD R F 5.00000 IS1RMP7 CORPORATE / Short: IS1RMP7 CDS USD P V 03MEVENT IS1RMQ8 CORPORATE
d. CUSIP (if any).	000000000
At least one of the following other identifiers:	
Identifier.	Other unique identifier (if ticker and ISIN are not available). Indicate the type of identifier used
Other unique identifier (if ticker and ISIN are not available). Indicate the type of identifier used	99S16XYL9
Description of other unique identifier.	Internal Identifier
Item C.2. Amount of each investment.	
Balance. Indicate whether amount is expressed in number of shares, principal amount, or other units. For derivatives contracts, as applicable, provide the number of contracts.	
Balance	200000.00000000
Units	Other units
Description of other units.	Notional Amount
Currency. Indicate the currency in which the investment is denominated.	United States Dollar
Value. Report values in U.S. dollars. If currency of investment is not denominated in U.S. dollars, provide the exchange rate used to calculate value.	28053.48000000
Exchange rate.	
Percentage value compared to net assets of the Fund.	0.009595369135
Item C.3. Indicate payoff profile among the following categories (long, short, N/A). For derivatives, respond N/A to this Item and respond to the relevant payoff profile question in Item C.11.	
Payoff profile.	○ Long ○ Short ◉ N/A
Item C.4. Asset and issuer type. Select the category that most closely identifies the instrument among each of the following:	
Asset type (short-term investment vehicle (e.g., money market fund, liquidity pool, or other cash management vehicle), repurchase agreement, equity-common, equity-preferred, debt, derivative-commodity, derivative-credit, derivative-equity, derivative-foreign exchange, derivative-interest rate, derivatives-other, structured note, loan, ABS-mortgage backed security, ABS-asset backed commercial paper, ABS-collateralized bond/debt obligation, ABS-other, commodity, real estate, other). If "other," provide a brief description.	Derivative-credit

b. Counterparty.
i. Provide the name and LEI (if any) of counterparty (including a central counterparty).

Counterparty Record: 1

Name of counterparty.	Goldman Sachs International
LEI (if any) of counterparty.	W22LROWP2IHZNBB6K528

3. If the reference instrument is neither a derivative or an index, the description of the reference instrument s

Name of issuer.	Avis Budget Group, Inc.
Title of issue.	Avis Budget Group, Inc.

At least one of the following other identifiers:

Identifier.	ISIN (if CUSIP is not available)
ISIN (if CUSIP is not available).	USU05375AN77
Custom swap Flag	(•) Yes ( ) No

1. Description and terms of payments to be received from another party.
Receipts: Reference Asset, Instrument or Index.

Receipts: fixed, floating or other.	(•) Fixed ( ) Floating ( ) Other
Receipts: Fixed rate.	5
Receipts: Base currency.	United States Dollar
Receipts: Amount.	333.33000000

2. Description and terms of payments to be paid to another party.
Payments: Reference Asset, Instrument or Index

Payments: fixed, floating or other.	( ) Fixed ( ) Floating (•) Other
Description of Other Payments	sell protection
ii. Termination or maturity date.	2023-12-20

iii. Upfront payments or receipts

Upfront payments.	15988.72
ISO Currency Code.	United States Dollar
Upfront receipts.	0
ISO Currency Code.	United States Dollar
iv. Notional amount.	200000
ISO Currency Code.	USD

Appendix B: Example of Derivative Return Disclosure

This appendix provides aggregate return information about derivative positions of A.B. Limited Duration High Income Portfolio, extracted from its Form N-PORT as of December 31, 2020.

Asset category.	Credit Contracts
Monthly net realized gain(loss) – Month 1	-158905.82000000
Monthly net change in unrealized appreciation (or depreciation) – Month 1	204522.43000000
Monthly net realized gain(loss) – Month 2	-83049.83000000
Monthly net change in unrealized appreciation (or depreciation) – Month 2	416399.28000000
Monthly net realized gain(loss) – Month 3	-251789.69000000
Monthly net change in unrealized appreciation (or depreciation) – Month 3	353481.95000000

Asset category.	Foreign Exchange Contracts
Monthly net realized gain(loss) – Month 1	0.01000000
Monthly net change in unrealized appreciation (or depreciation) – Month 1	-1554463.21000000
Monthly net realized gain(loss) – Month 2	0.00000000
Monthly net change in unrealized appreciation (or depreciation) – Month 2	375327.65000000
Monthly net realized gain(loss) – Month 3	0.00000000
Monthly net change in unrealized appreciation (or depreciation) – Month 3	-571843.27000000

Asset category.	Interest Rate Contracts
Monthly net realized gain(loss) – Month 1	0.00000000
Monthly net change in unrealized appreciation (or depreciation) – Month 1	52915.05000000
Monthly net realized gain(loss) – Month 2	-66927.07000000
Monthly net change in unrealized appreciation (or depreciation) – Month 2	21238.10000000
Monthly net realized gain(loss) – Month 3	127101.79000000
Monthly net change in unrealized appreciation (or depreciation) – Month 3	-140750.63000000

Appendix C: Variable Description

Variable Name	Definition
$I_{Forward}$	Dummy for whether a derivative is a forward.
I_{Future}	Dummy for whether a derivative is a future.
I_{Swap}	Dummy for whether a derivative is a swap.
$I_{Swaption}$	Dummy for whether a derivative is a swaption.
I_{Option}	Dummy for whether a derivative is an option.
$I_{Credit\ derivative}$	Dummy for whether a derivative is a credit derivative.
$I_{Interest\ rate\ derivative}$	Dummy for whether a derivative is an interest rate derivative.
$I_{Currency\ derivative}$	Dummy for whether a derivative is a currency derivative.
Asset weight	Absolute portfolio weight of a derivative.
Notional amount	The notional value of a derivative instrument.
Remaining years to settlement	The number of years until a derivative's settlement date.
$I_{Speculator}$	Dummy for whether a fund is a derivative speculator. I compute the correlation between derivative and non-derivative returns for each fund over a specified period. A derivative speculator is a fund with a correlation above the median.
I_{Hedger}	Dummy for whether a fund is a derivative hedger. A derivative hedger is a fund with a correlation below the median.
# of Derivatives	The number of derivative positions in a fund's portfolio.
Total asset weight	The sum of absolute portfolio weights of all derivatives.
Total asset weight (credit)	The sum of absolute portfolio weights of all credit derivatives.
Total asset weight (interest rate)	The sum of absolute portfolio weights of all interest rate derivatives.
Total asset weight (currency)	The sum of absolute portfolio weights of all currency derivatives.
Gross exposure	The sum of the gross notional amount of all derivatives.
Gross exposure (credit)	The sum of the gross notional amount of all credit derivatives.
Gross exposure (interest rate)	The sum of the gross notional amount of all interest rate derivatives.
Gross Exposure (currency)	The sum of the gross notional amount of all currency derivatives.
Derivative return	The sum of realized profit or loss and change of unrealized profit or loss in the current month, scaled by the fund's total net asset in the previous month.
Non-derivative return	The difference between the fund returns and the derivative returns.
Fund TNA	Fund total net assets in millions.
Fund age	The number of months since a fund's inception date.

12-month style-adjusted return	Cumulative style-adjusted fund returns over the prior 12 months. The fund style is based on Lipper's objective code.
Quarterly fund flow	The sum of the monthly percentage change in fund-level AUM with an adjustment of monthly fund returns.
Cash holding	The proportion of fund assets in cash.
Fraction of institutional shares	The number of institutional share classes scaled by the total number of share classes.
Fund return volatility	The standard deviation of fund returns over the past 24 months.
Fund maturity	The weighted average of maturities of bond holdings
Fund illiquidity	The weighted average of Amicus's illiquidity ratio of bond holdings.
Interest rate risk	The portfolio value change of a 1-basis-point change in interest rates.
Credit risk	The portfolio value change of a 1-basis-point change in credit spread.
Global uncertainty beta	The regression coefficient on the World Uncertainty Index of Ahir, Bloom, and Furceri (2018) in a 24-month rolling window.
Bond liquidation	The negative percentage change in its par value in a fund's portfolio from 2019 Q4 to 2020 Q1.
Bond return	The daily bond return formula is as follows $$\frac{p_t - C_t/360}{p_{t-1}} - 1$$ where p_t denotes the weighted average of transaction prices at day t based on the dollar trading volume of each transaction price, and C_t is the annualized coupon rate.
Bond return volatility	The standard deviation of daily bond returns in a month.
Net speculator ownership	The difference between derivative speculators' ownership and derivative hedgers' ownership as of 2019 Q4. Derivative speculators' (hedgers) ownership is the par values of bond shares held by derivative speculators (hedgers), scaled by par values of bond shares held by mutual funds.
Derivative nonuser ownership	The number of shares held by derivative nonusers normalized by the number of shares held by mutual funds.
Bond Amihud illiquidity	The absolute value of daily price changes divided by the dollar trading volume. The quarterly measure is the average of daily Amihud ratios over a quarter.
Bond age	The number of months since a bond's offering date.
Time to maturity	The number of months until a bond's maturity date.
Trade volume	Total bond dollar trading volume in a month.

Table 1: Sample of Corporate Bond Mutual Funds

Year quarter	All fund	Derivative user	Credit derivative user	Interest rate derivative user	Currency derivative user
2019 Q3	663	379	183	318	166
2019 Q4	662	389	194	326	168
2020 Q1	666	402	212	338	171
2020 Q2	659	390	190	334	170
2020 Q3	646	390	193	324	167
2020 Q4	645	390	161	328	176
2021 Q1	656	411	183	336	182
2021 Q2	657	417	194	343	177
2021 Q3	654	420	190	346	174
2021 Q4	655	355	157	289	159

This table displays the number of sample funds, the number of derivative users, the number of credit derivative users, the number of interest rate derivative users, and the number of currency derivative users in each sample year-quarter.

Table 2: Fund Level Summary Statistics

	Mean	SD	P25	P50	P75
Panel A Derivative contract-level statistics					
$I_{Forward}$	0.302	0.459	0.000	0.000	1.000
I_{Future}	0.131	0.338	0.000	0.000	0.000
I_{Swap}	0.405	0.491	0.000	0.000	1.000
$I_{Swaption}$	0.080	0.272	0.000	0.000	0.000
I_{Option}	0.081	0.273	0.000	0.000	0.000
$I_{Credit\ derivative}$	0.246	0.431	0.000	0.000	0.000
$I_{Interest\ rate\ derivative}$	0.418	0.493	0.000	0.000	1.000
$I_{Currency\ derivative}$	0.320	0.467	0.000	0.000	1.000
Asset weight (%)	0.080	0.809	0.000	0.002	0.012
Notional amount ($ million)	32.670	106.501	0.589	3.000	15.111
Remaining years to settlement (as of report date)	5.612	11.321	0.131	0.308	4.794
Panel B Fund-level derivative statistics					
$I_{Speculator}$	0.192	0.394	0.000	0.000	0.000
I_{Hedger}	0.350	0.477	0.000	0.000	1.000
# of Derivatives	23.644	71.572	0.000	3.000	11.000
Total asset weight (%)	1.970	8.784	0.000	0.050	0.474
Total asset weight (credit %)	0.142	0.805	0.000	0.000	0.015
Total asset weight (interest rate %)	1.741	8.391	0.000	0.008	0.249
Total asset weight (currency %)	0.082	0.603	0.000	0.000	0.003
Gross Exposure (%)	31.875	66.218	0.000	4.395	34.105
Gross Exposure (credit %)	2.572	7.941	0.000	0.000	0.832
Gross Exposure (interest rate %)	25.572	56.027	0.000	1.893	26.839
Gross Exposure (currency %)	2.333	6.798	0.000	0.000	0.190
Panel C Fund return statistics					
Fund return (%)	0.344	1.883	-0.161	0.250	0.976
Derivative return (D.R. %)	0.022	0.723	-0.013	0.000	0.020
Non-derivative return (non-D.R. %)	0.323	1.975	-0.179	0.255	0.990
Relative Contribution of D.R. to Non-D.R.	0.395	1.155	0.000	0.025	0.262
Panel D Fund characteristics					
TNA ($million)	2,861.874	8,361.000	148.700	538.700	1,823.200
Fund age (month)	20.201	12.674	9.917	20.250	28.083
12-month style-adjusted return (%)	0.026	2.134	-0.817	-0.033	0.758
Quarterly fund flow	2.468	15.124	-2.329	0.743	4.727
Cash holding (%)	-0.987	9.909	-0.840	0.870	2.550
Fraction of institutional shares (%)	44.437	35.398	0.000	50.000	66.667
Return volatility (%)	1.624	0.955	0.971	1.323	2.288
Fund maturity (years)	9.947	4.564	6.283	9.568	13.511
Fund illiquidity (Amihud %)	4.828	2.556	3.131	4.403	5.877
Interest rate risk	0.048	0.051	0.029	0.047	0.058
Credit risk	0.053	0.084	0.024	0.037	0.051
Global uncertainty beta	0.000	0.008	-0.003	0.001	0.004

This table presents descriptive statistics of individual derivative positions, fund-level derivative information, fund return information, and fund characteristics. All variables are winsorized at the 1st and 99th percentile. Append C contains variable descriptions.

Table 3: Bond Level Summary Statistics

Variables	Mean	SD	P25	P50	P75
Daily return (before crisis, %)	0.051	0.539	-0.113	0.034	0.228
Daily return (during crisis, %)	-1.370	3.522	-2.690	-0.762	0.161
Daily return (post-crisis, %)	0.519	2.249	-0.275	0.189	1.050
Monthly return volatility (%)	1.227	1.374	0.251	0.638	1.723
Bond liquidation (%)	16.102	46.097	0.000	0.000	10.119
Net speculator ownership	-0.028	0.494	-0.399	-0.027	0.319
Derivative nonuser ownership	0.282	0.271	0.054	0.205	0.440
Log (Bond age)	3.711	0.926	3.163	3.823	4.380
Log (Time to Maturity)	4.174	1.089	3.548	4.212	4.781
Log (Trade Volume)	0.839	0.787	0.182	0.599	1.324

This table reports summary statistics of bond characteristics. The before-crisis period is from January 1, 2020 to March 05, 2020; the crisis period is between March 06, 2020 and March 23, 2020; and post-crisis period is March 24, 2020 to April 30, 2020. The bond ownership variables are recorded as of 2019 Q4. Other time-varying bond characteristics are measured from January 2020 to April 2020. All variables are winsorized at the 1st and 99th percentile. Append C contains variable descriptions.

Table 4: Cross-sectional Determinants of Derivative Usage

Dependent variable	(1) Gross exposure	(2) Speculator dummy	(3) Hedger dummy
Log (TNA)	0.090**	0.014**	0.028***
	(2.376)	(2.363)	(3.481)
Log (Fund age)	-0.097	0.032**	-0.034*
	(-1.101)	(2.417)	(-1.802)
Cash holding	-0.042***	-0.001	-0.006***
	(-6.829)	(-0.597)	(-4.309)
Fund maturity	0.092***	0.003	0.012***
	(4.403)	(1.014)	(2.731)
Return volatility	0.200*	0.049***	0.015
	(1.802)	(3.055)	(0.649)
Fraction of institutional shares	-0.304	0.050*	-0.109***
	(-1.631)	(1.845)	(-2.783)
Interest rate risk	3.246**	-0.274**	0.762***
	(2.529)	(-2.044)	(2.685)
Credit risk	-1.975***	-0.169*	-0.342*
	(-2.992)	(-1.701)	(-1.781)
Global uncertainty beta	0.266***	-0.002	0.047***
	(3.380)	(-0.150)	(2.898)
Fund Style FE	YES	YES	YES
Year Quarter FE	YES	YES	YES
Observations	5,143	5,145	5,145
Adjusted R-squared	0.208	0.044	0.072

This table shows the cross-sectional determinants of funds' derivative usage. In Column 1, the dependent variable is the gross notional amount of all the derivative positions. The dependent variables in Columns 2 and 3 are the speculator and hedger dummy, respectively. All specifications include fund style (Lipper objective codes) /year-quarter fixed effects. Standard errors are clustered at the fund and year-quarter levels, and corresponding t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Table 5: Bond Liquidation of Derivative Speculator and Hedger

Dependent variable	(1) Bond Liquidation	(2) Bond Liquidation
$I_{Speculator}$	0.820**	1.078***
	(2.081)	(2.844)
I_{Hedger}	-0.840*	-1.136**
	(-1.790)	(-2.328)
Log (TNA)		-1.191***
		(-9.740)
Log (Fund age)		-1.701***
		(-7.773)
12-month style-adjusted return		0.416***
		(2.903)
Return volatility		-4.036***
		(-5.758)
Cash holding		-0.051***
		(-3.321)
Cumulative fund flow		-0.277***
		(-16.450)
Fund illiquidity		-0.036
		(-0.298)
Fund maturity		0.426***
		(3.990)
Bond FE	YES	YES
Issuer FE	YES	YES
Issuer-Industry FE	YES	YES
Fund-Style FE	YES	YES
Observations	158,115	148,960
Adjusted R-squared	0.189	0.193
P-value: Speculator = Hedger	0.000	0.000

The table displays the results of regressing bond-fund-level liquidations on dummies for derivative speculators and hedgers. A bond's liquidation is the negative percentage change in its par value in a fund's portfolio from 2019 Q4 to 2020 Q1. I compute the correlation between derivative and non-derivative returns for each fund between July 2019 and January 2020. A derivative speculator (hedger) is a fund with a return correlation above (below) the median. All specifications include bond issue, bond issuer, bond issuer industry (2-digit SIC), and fund style (Lipper objective codes) fixed effects. Standard errors are clustered at the bond issuer level, and corresponding t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Table 6: Bond Liquidation: Cross-sectional Tests

Panel A: Bond characteristics

Partition variable	(1) Amihud Illiquidity (Low)	(2) Amihud Illiquidity (High)	(3) Return Volatility (Low)	(4) Return Volatility (High)
$I_{Speculator}$	1.678***	-0.112	1.861***	0.028
	(3.308)	(-0.190)	(4.165)	(0.043)
I_{Hedger}	0.219	-3.204***	0.116	-2.872***
	(0.390)	(-4.378)	(0.207)	(-3.758)
Fund-Controls	YES	YES	YES	YES
Bond FE	YES	YES	YES	YES
Issuer FE	YES	YES	YES	YES
Issuer-Industry FE	YES	YES	YES	YES
Fund-Style FE	YES	YES	YES	YES
Observations	74,111	61,322	79,010	56,423
Adjusted R-squared	0.193	0.169	0.225	0.117
P-value: Speculator = Hedger	0.002	0.000	0.001	0.000

Panel B: Fund characteristics

Interaction variable	(1) Return Contribution	(2) Gross Exposure	(3) Fund Illiquidity	(4) Cash Holding
$I_{Speculator} \times LowChar$	-0.424	-1.341***	-2.842***	1.803***
	(-0.948)	(-2.931)	(-5.641)	(4.159)
$I_{Speculator} \times HighChar$	1.476***	3.861***	4.147***	-0.530
	(3.186)	(7.211)	(9.498)	(-1.173)
$I_{Hedger} \times LowChar$	2.261***	-1.114**	-2.480***	-2.204***
	(4.602)	(-2.077)	(-4.515)	(-3.892)
$I_{Hedger} \times HighChar$	-6.635***	-1.450**	0.006	0.619
	(-9.663)	(-2.380)	(0.011)	(1.121)
Fund-Controls	YES	YES	YES	YES
Bond FE	YES	YES	YES	YES
Issuer FE	YES	YES	YES	YES
Issuer-Industry FE	YES	YES	YES	YES
Fund-Style FE	YES	YES	YES	YES
Observations	148,960	148,960	148,960	148,960
Adjusted R-squared	0.196	0.194	0.195	0.194
P-value (Speculator): Low = High	0.000	0.000	0.000	0.000
P-value (Hedger): Low = Hight	0.000	0.588	0.000	0.000

The table presents the results of cross-sectional tests of bond liquidations. Panel A shows subsample results based on bond Amihud's illiquidity and return volatility. Panel B displays cross-sectional results based on fund characteristics, including return contribution, gross notional exposure, fund illiquidity, and cash holding. All specifications include the fund controls in table 5, bond issue, bond issuer, bond issuer industry (2-digit SIC), and fund style (Lipper objective codes) fixed effects. Standard errors are clustered at the bond issuer level, and corresponding t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Table 7: Price Impact of Derivative Speculation and Hedge

Dependent variable	(1) Bond Return	(2) Bond Return	(3) Bond Return	(4) Bond Return
Net speculator ownership × crisis	-0.237***	-0.203***		
	(-2.922)	(-2.862)		
Derivative nonuser ownership × crisis	0.098	0.034		
	(1.167)	(0.499)		
Net speculator ownership × recover			0.238***	0.217***
			(2.959)	(2.996)
Derivative nonuser ownership × recover			-0.065	-0.041
			(-1.050)	(-0.777)
Log (Bond age)		-0.659*		0.630
		(-1.806)		(1.123)
Log (Time to maturity)		-4.933***		3.670
		(-2.800)		(1.600)
Log (Trade volume)		-0.032		-0.073***
		(-1.576)		(-2.737)
Bond FE	YES	YES	YES	YES
Issuer Date FE	YES	YES	YES	YES
Issuer Industry Date FE	YES	YES	YES	YES
Rating Date FE	YES	YES	YES	YES
Observations	200,874	200,874	155,644	155,644
Adjusted R-squared	0.371	0.377	0.358	0.359

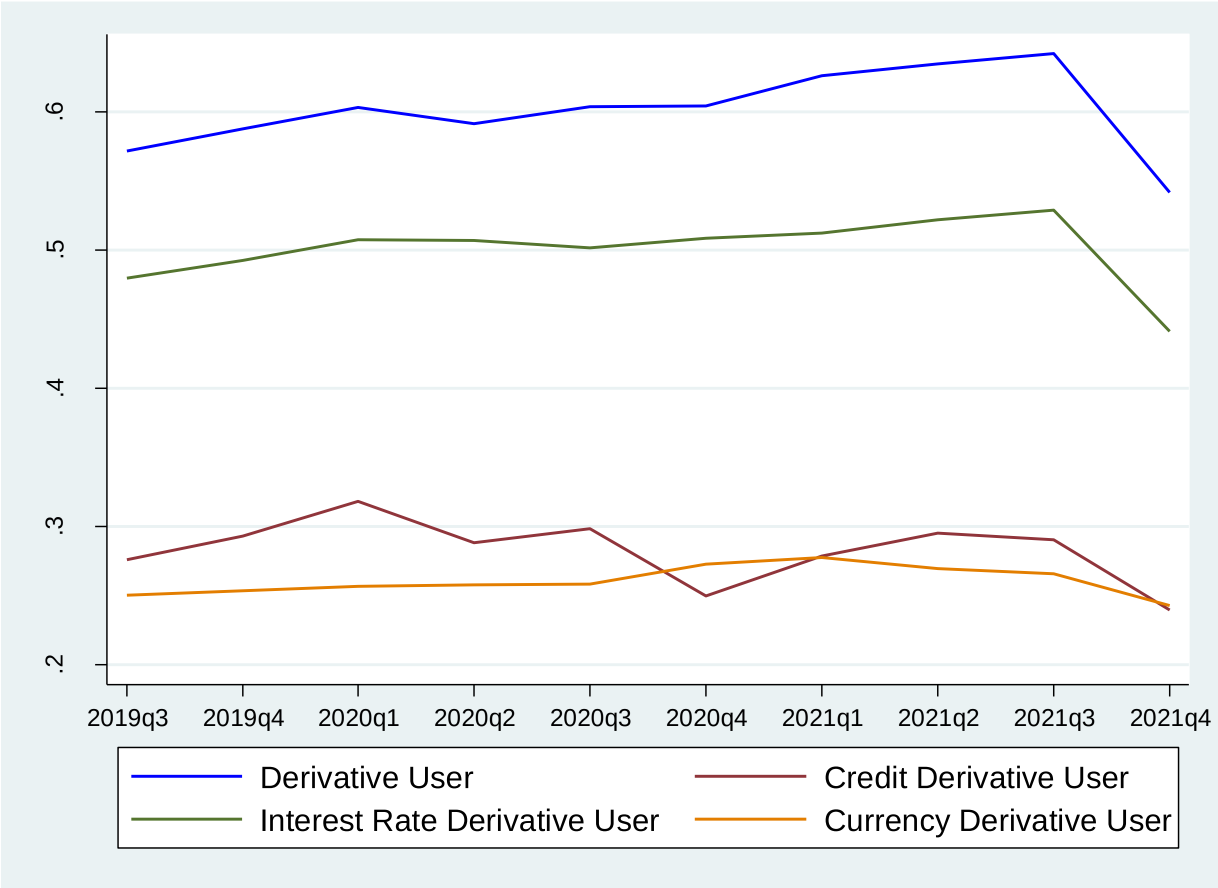
The table reports the relation between daily bond returns and net speculators' ownership during and after the Covid-19 crisis. In columns 1 and 2 (3 and 4), the sample period spans from January 1, 2020 to March 23, 2020 (March 1, 2020 to April 30, 2020). The net speculation ownership is the difference between derivative speculators' ownership and derivative hedgers' ownership as of 2019 Q4. Crisis (recover) is a dummy that equals one after March 6, 2020 (March 23, 2020). All specifications include the bond issue, bond-issuer-day, bond-issuer-industry-day (2-digit SIC), and bond-rating-day fixed effects. Standard errors are clustered at the bond and date levels, and corresponding t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Table 8: Derivative Speculation and Hedge and Bond Return Volatility

Dependent variable	(1) Bond Volatility	(2) Bond Volatility
Net speculator ownership × crisis	0.259***	0.237***
	(9.736)	(9.297)
Derivative nonuser ownership × Crisis	0.112***	0.083***
	(10.123)	(6.125)
Net speculator ownership × recover	-0.100	-0.072
	(-1.898)	(-1.469)
Derivative nonuser ownership × recover	-0.018	0.024
	(-0.885)	(0.954)
Log (Bond age)		0.130
		(1.890)
Log (Time to maturity)		2.253
		(2.241)
Log (Trade volume)		0.025
		(0.446)
Bond FE	YES	YES
Issuer Date FE	YES	YES
Issuer Industry Date FE	YES	YES
Rating Date FE	YES	YES
Observations	19,104	19,103
Adjusted R-squared	0.811	0.820

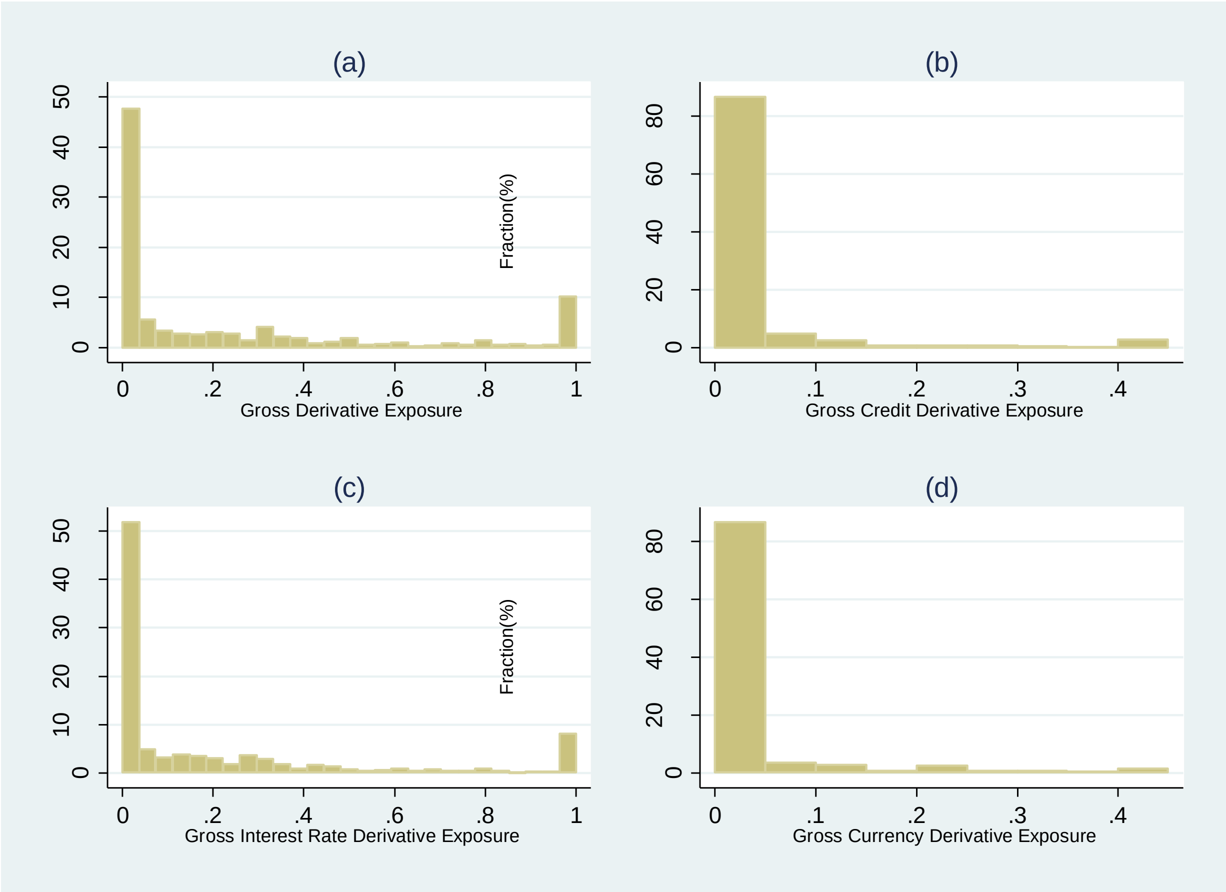
The table summarizes the results of the relation between monthly bond return volatility and net speculators' ownership during and after the Covid-19 crisis. The sample period spans from January 2020 to March 2020. The net speculation ownership is the difference between derivative speculators' ownership and derivative hedgers' ownership as of 2019 Q4. Crisis (recover) is a dummy that equals one in March 2020 (April 2020). All specifications include the bond issue, bond-issuer-year-month, bond-issuer-industry-year-month (2-digit SIC), and bond-rating-year-month fixed effects. Standard errors are clustered at the bond and year-month levels, and corresponding t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Figure 1: Sample of Derivative Funds



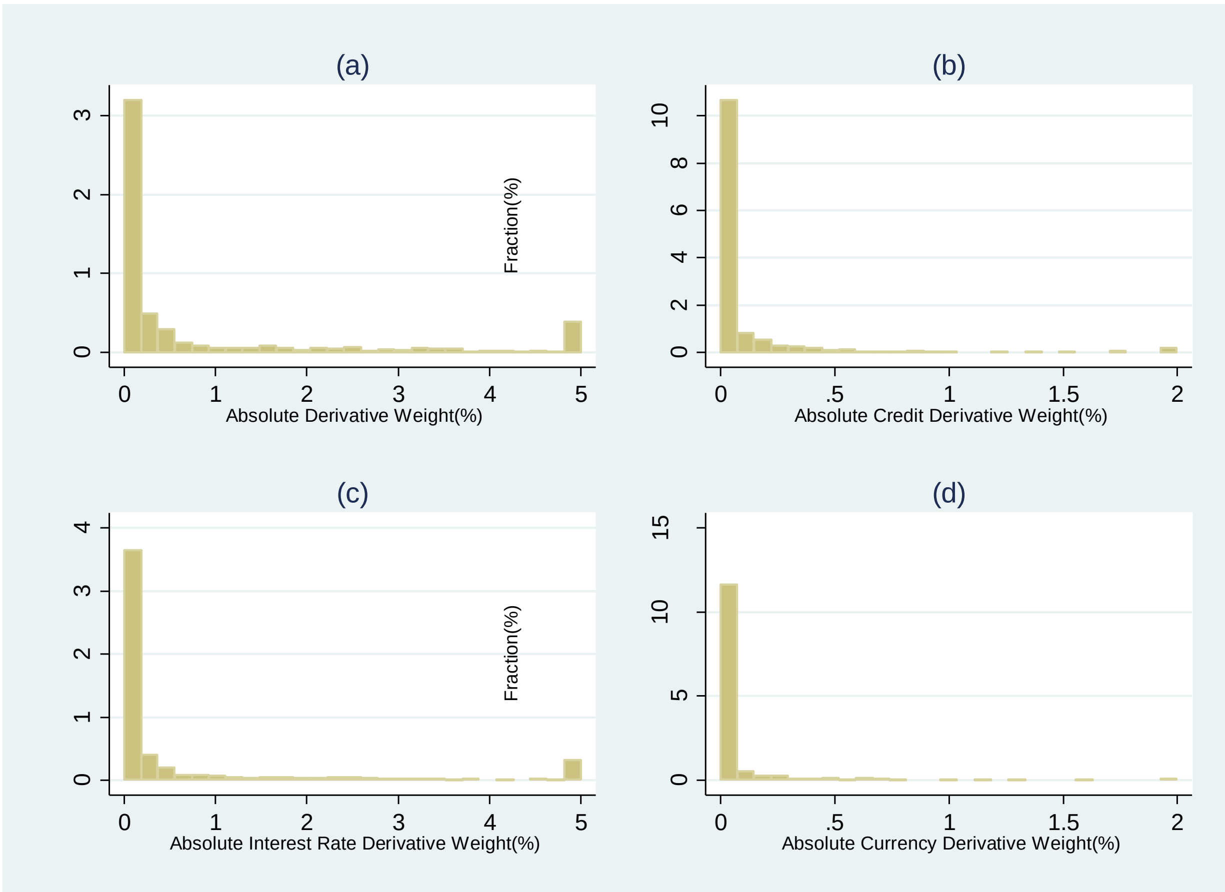
The figure plots the fraction of derivative users, credit derivative users, interest rate derivative users, and currency derivative users in each sample year-quarter.

Figure 2: Distribution of Gross Derivative Exposure



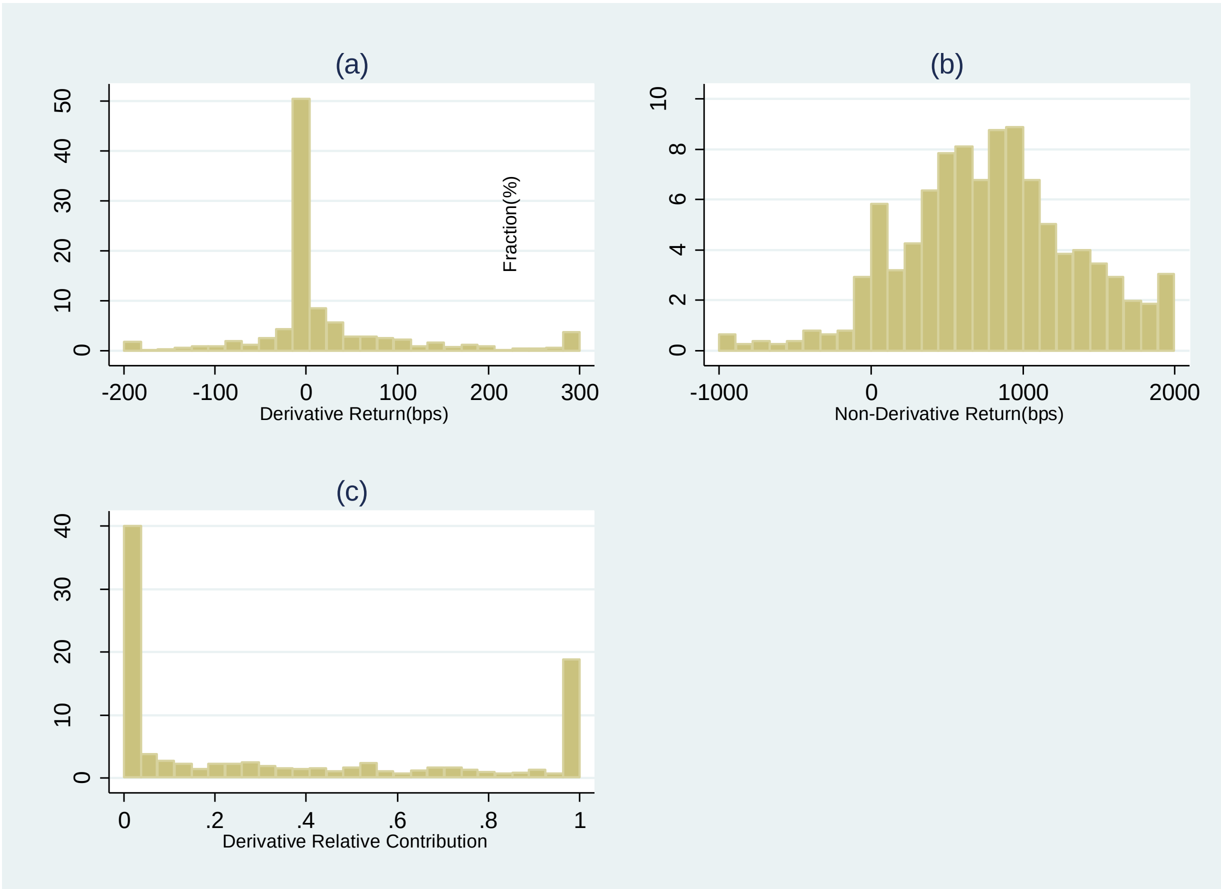
The figure reports histograms of (a) gross derivative exposure, (b) gross credit derivative exposure, (c) gross interest rate derivative exposure, and (d) gross currency derivative exposure. I first sum the notional amount of all derivative positions for each fund. I then average the aggregate derivative exposure for each fund by using its observations from Q3 2019 to Q4 2021. Each derivative exposure measure is normalized by the fund's total net assets. Gross derivative exposure (gross interest rate derivative exposure) is winsorized at 0 and 1. Gross credit derivative exposure (gross currency derivative exposure) is winsorized at 0 and 0.4.

Figure 3: Distribution of Asset weights of Derivative Positions



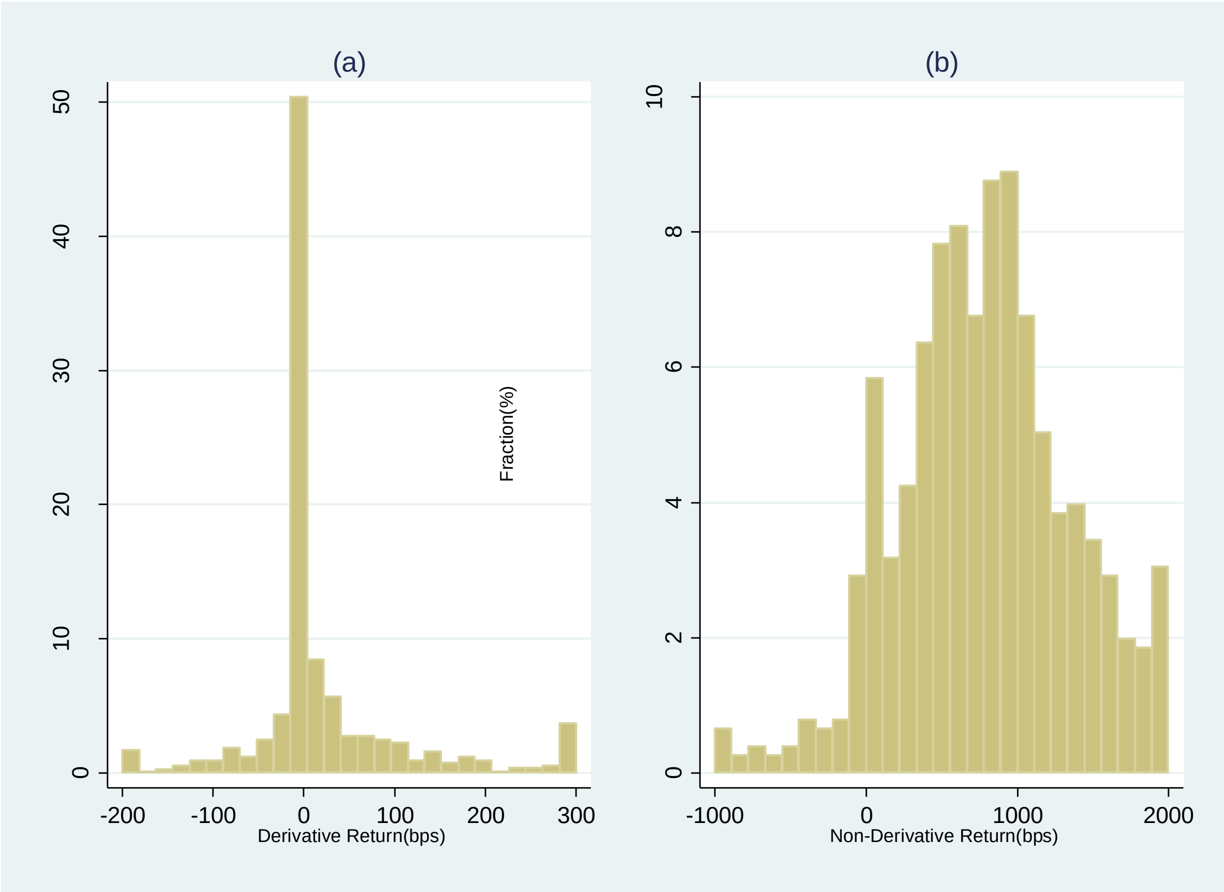
The figure displays histograms of (a) derivative asset weight, (b) credit derivative asset weight, (c) interest rate derivative asset weight, and (d) currency derivative asset weight. I first sum the absolute asset weight of all derivative positions for each fund. I then average the aggregate asset weights for each fund by using its observations from Q3 2019 to Q4 2021. Each asset weight measure is scaled by the fund's total net assets. Derivative asset weights (interest rate derivative weights) are winsorized at 0 and 5. Credit derivative asset weights (currency derivative weights) are winsorized at 0 and 2.

Figure 4: Distribution of Derivative Returns



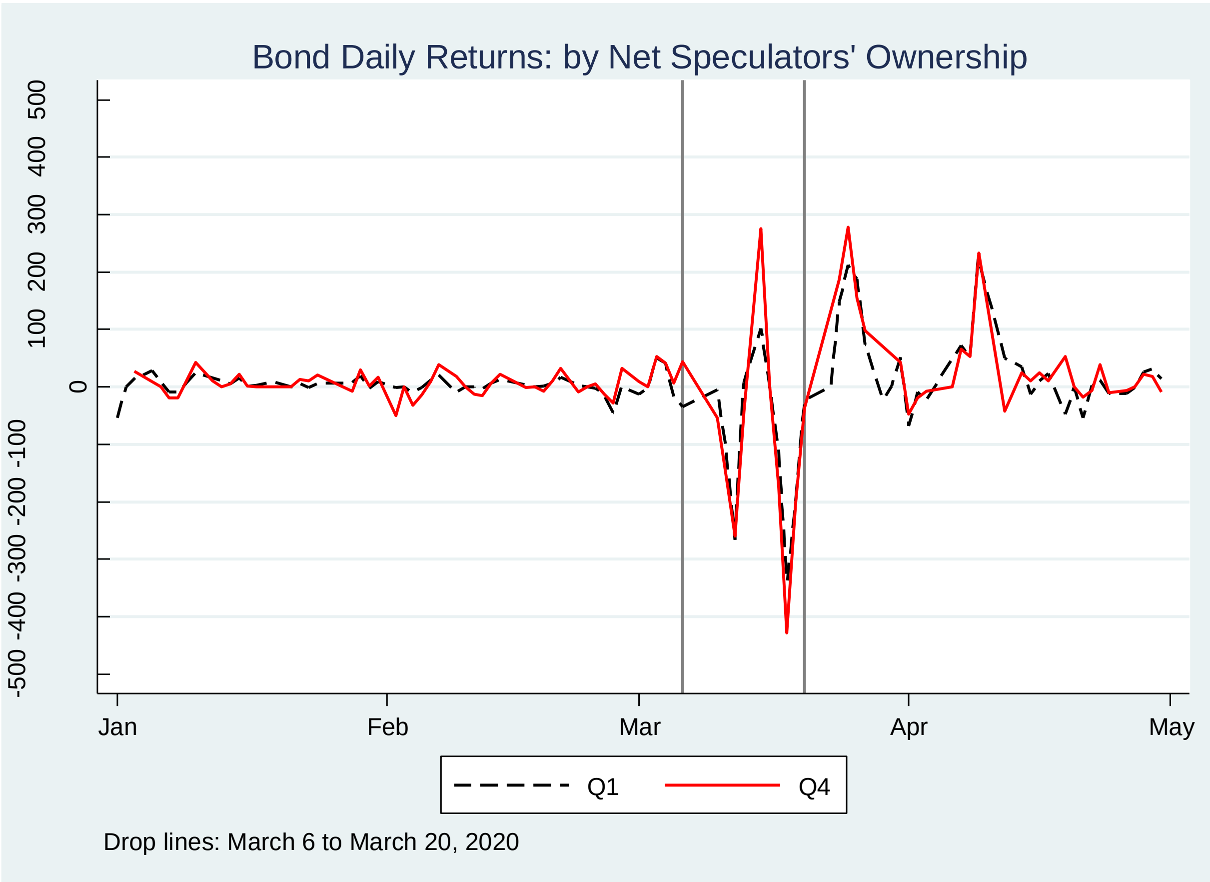
The graph presents the histogram of (a) derivative return, (b) non-derivative return, and (c) absolute ratio of derivative and non-derivative return. The monthly derivative return is computed as the sum of realized profit or loss and change of unrealized profit or loss in the current month, scaled by the fund's total net asset in the previous month. Non-derivative return is the difference between the fund return and the derivative return. I sum all derivative and non-derivative returns for each fund by using its observations from July 2019 to December 2021. Derivative returns (non-derivative returns) are winsorized at -200 (-1000) bps and 300 (2000) bps, respectively. The relative contribution is winsorized at 0 and 1.

Figure 5: Distribution of the Correlation between Derivative and Non-derivative Return



The graph presents the histogram of the correlation between derivative return and non-derivative return. The monthly derivative return is computed as the sum of realized profit or loss and change of unrealized profit or loss in the current month, scaled by the fund's total net asset in the previous month. Non-derivative return is the difference between the fund return and the derivative return. In Panel (a), I calculate the return correlation for each derivative fund with at least 12 non-zero derivative returns by using its observations from July 2019 to December 2021. In Panel (b), I compute the return correlation for each derivative fund with at least five non-zero derivative returns by using its observations from July 2019 to January 2020.

Figure 6: Derivative Speculation and Bond Returns



The figure plots daily bond returns (in basis points) by quartiles of net speculator ownership during the Covid-19 crisis. The sample period spans from January 1, 2020 to April 30, 2020, with crisis time marked by two drop lines. The net speculation ownership is the difference between derivative speculators' ownership and derivative hedgers' ownership as of 2019 Q4. Bonds are ranked into quartiles based on the net speculator ownership in 2019 Q4. Bonds in the fourth quarter have the highest proportion of net speculator ownership, while bonds in the first quartile have the lowest proportion. The bond returns in each quartile group are weighted by the amount outstanding.