Stress-Tested: Municipal Bond ETFs During Market Turmoil

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Abstract

Financial innovations like exchange-traded funds (ETFs) are often credited with enhancing market efficiency and liquidity, but these benefits may not extend to all asset classes. This paper examines why municipal bond ETFs (Muni ETFs) experienced large and persistent price deviations from net asset value (NAV) during the COVID-19 crisis. The creation and redemption mechanism failed to close price-NAV gaps, suggesting a breakdown in arbitrage activity. Using bond-level trade data, I find no evidence of that arbitrage participants remained active while small trades dominated sell activity for ETF-held bonds. In contrast, bonds held by municipal bond mutual funds experienced increased trading volume, consistent with flow-driven selling. These findings suggest that, while the Muni ETF mechanism did not trigger fire sales in the underlying market, it left most selling pressure in the ETF secondary market. The results highlight structural fragilities in ETF arbitrage mechanisms in illiquid markets, especially under stress.

Keywords: Municipal bonds, Exchange-traded fund, Dealer, Market liquidity, Market turmoil

JEL Codes: G12, G14, G23

1 Introduction

Municipal bond ETFs (Muni ETFs) have grown significantly since they first appeared on the market. Especially after COVID, they have grown by 119 percent, as measured by assets under management (AUM), while Muni mutual funds (Muni MFs) have slightly decreased (Panel A of Table 1). This growth in Muni ETF market share has raised concerns about how the ETF mechanism contributes to the liquidity mismatch between the highly liquid ETF market and the relatively illiquid underlying bond market (Marlowe, 2020).[1] These concerns become particularly relevant during periods of market turmoil, when pricing efficiency and liquidity conditions are most strained (Dannhauser and Hoseinzade, 2021; Li et al., 2023). While ETFs are designed to track their underlying assets closely (Ben-David et al., 2018), Muni ETFs experienced prolonged dislocations from NAV, raising questions about the effectiveness of their arbitrage mechanisms in stressed market conditions.

This paper investigates why Muni ETF prices exhibited large and persistent deviations from net asset value (NAV) during the COVID-19 market turmoil. ETF prices are expected to remain aligned with NAV through arbitrage by Authorized Participants (APs), who create and redeem shares based on price differences between the ETF and its underlying securities (Dannhauser, 2017; Finnerty et al., 2024). However, in March 2020, Muni ETFs experienced some of the largest and most prolonged pricing dislocations across all ETF categories. Deviations between ETF prices and NAVs widened dramatically, and persisted for an extended period. The persistence of these deviations suggests a possible breakdown in the arbitrage process, raising questions about the conditions under which ETF mechanism can fail, particularly in fixed-income markets with liquidity constraints.

Periods of financial distress typically lead to increased demand for liquidity, with investors prioritizing the sale of their most liquid assets first (Beber et al., 2009). Unlike individual municipal bonds, which trade in fragmented over-the-counter (OTC) markets

[1] https://www.financialresearch.gov/annual-reports/files/office-of-financial-research-annual-report-2013.pdf

with limited liquidity, Muni ETFs provide an exchange-traded mechanism for accessing liquidity (Bagley et al., 2022; Griffin et al., 2023). Consequently, ETF shares experienced substantial selling pressure during the COVID-19 crisis, leading to sharp declines in ETF prices while NAVs, calculated from relatively illiquid municipal bond prices, adjusted more slowly. This liquidity-driven selling pressure should have presented arbitrage opportunities, yet NAV deviations persisted despite significant price gaps, suggesting that APs did not engage in arbitrage to the extent expected (Dannhauser and Hoseinzade, 2021).

To empirically examine the drivers of ETF pricing dislocations, I use a difference-in-differences (DiD) framework to examine why the price deviation between ETFs and their NAVs fails to close efficiently during periods of market turmoil. If AP arbitrage were functioning properly, increased institutional trading and fund outflows would be reflected in bond-level activity, as AP offloads bonds into the market through in-kind redemptions when ETF prices fall below NAV (Fulkerson et al., 2017). However, the results indicate that ETF fund outflows did not lead to higher trading volumes in the underlying bonds, suggesting that APs were not actively redeeming shares and selling municipal bonds. Instead, I find that trading volume increased in ETF-held bonds, with most of the increase concentrated in smaller-sized trades ($<$ \$100,000). These findings reinforce the view that ETF NAV deviations persisted because APs refrained from transacting in the illiquid municipal bond market, allowing mispricing to persist.

Further analysis reveals that dealers provided significantly less liquidity support for ETF-held bonds than for bonds held exclusively by mutual funds—a critical distinction given the structural differences between the two. Mutual funds must sell underlying assets to meet redemptions, while ETF redemptions rely on APs, who are not obligated to act and conduct in-kind transactions. The weaker dealer support for ETF-held bonds likely worsened pricing dislocations by dampening APs' incentives to engage in arbitrage under strained liquidity.

Additionally, the findings highlight the importance of targeted Federal Reserve interventions in restoring market stability. Although the Municipal Liquidity Facility (MLF), announced on April 9, 2020, did not purchase municipal bond ETFs directly, it helped stabilize the broader muni market. Only after this intervention did ETF prices begin to realign with NAV, underscoring the role of policy actions in restoring confidence and resolving structural dislocations.

To investigate these issues, I conduct a series of empirical tests structured around three components. First, I measure the severity and persistence of NAV deviations across Muni ETFs and benchmark them against other ETF categories. Second, I test whether the ETF arbitrage mechanism was active by examining changes in trading volume, and the relationship between fund flows and bond-level activity. Third, I assess whether the municipal bond market's structure—including dealer participation and bond illiquidity—contributed to arbitrage failure by limiting the ability of AP to transact efficiently. These tests collectively evaluate whether structural frictions prevented arbitrage from correcting ETF mispricing during the COVID-19 crisis.

This study contributes to the growing literature on the role of bond ETFs in market functioning and liquidity dynamics. While ETFs have existed since 1993, academic research on fixed-income ETFs is still evolving. Early work by Dannhauser (2017) shows that ETF ownership affects valuation but has mixed effects on underlying bond liquidity, suggesting that ETFs may attract liquidity traders away from the bonds themselves. Building on this, Pan and Zeng (2017) develop a theoretical model where APs, who often double as bond dealers, exploit ETF share creation and redemption mechanisms to manage inventory and capture arbitrage opportunities during ETF price dislocations. More recent empirical work has explored how AP behavior, basket design, and fund flows affect underlying bond liquidity across corporate and high-yield markets (Holden and Nam, 2024; Marta, 2021; Koont et al., 2022). These studies highlight the distinct roles played by ETF spnosors and APs in shaping bond market outcomes through the ETF mechanism.

However, relatively little is known about how these mechanisms operate in the Muni ETF space, which differs from the corporate bond market in several key respects: higher fragmentation, a larger retail investor base, and even lower secondary market liquidity. This paper is among the first to examine ETF pricing dislocations and arbitrage behavior in the municipal bond market during a crisis period. By using granular data on fund holdings, trade sizes, and dealer activity, this study offers new insights into when and why arbitrage may fail in fixed-income ETFs—and what role retail-driven flows and dealer support play in shaping those outcomes. These findings deepen our understanding of ETF behavior in illiquid markets and contribute to broader debates about whether ETFs amplify or absorb stress during market turmoil.

The remainder of the paper is organized as follows. Section 2 outlines the institutional background of Muni ETFs during the COVID crisis and develops the hypotheses. Section 3 describes the data sources and empirical design. Section 4 examines how market stress affects Muni ETF pricing. Section 5 explores the mechanisms underlying the persistent price dislocations. Section 6 presents robustness checks, and Section 7 concludes.

2 Institutional Framework and Hypothesis Development

2.1 ETF and Municipal Bond Market Structure

The municipal bond market has traditionally been characterized by lower liquidity and greater fragmentation compared to other fixed-income markets. These structural features stem from the over-the-counter (OTC) nature of municipal bond trading, the vast number of issuers, and the buy-and-hold preferences of many long-term investors (Green et al., 2007; Harris and Piwowar, 2006). Unlike corporate or Treasury markets, the structure of the municipal bond market, characterized by a high number of CUSIPs and issuers, contributes to fragmentation and limited liquidity.[2]

[2] https://www.msrb.org/sites/default/files/MSRB-Dealer-Participation-and-Concentration-Report.pdf

Muni ETFs were introduced to offer greater accessibility, liquidity, and transparency to investors seeking diversified exposure to municipal debt. Since the launch of the iShares National Muni Bond ETF (MUB) in 2007, the market for Muni ETFs has expanded significantly.[3] From 2008 through 2016, Muni ETFs' AUM grew at an average annual rate of 35.4% (Wu and Burns, 2018), reflecting a broader trend of ETF adoption across fixed-income asset classes. BlackRock, the ETF industry's largest provider, projects that global bond ETF assets could triple to $6 trillion by 2030.[4] The rapid growth of ETFs in a fundamentally illiquid market has raised important questions about their behavior during stress events (Bessembinder et al., 2018; Choi et al., 2019).

2.2 ETF Under Market Stress

During periods of market turmoil, investors generally prioritize liquidity.[5] Moreover, ETFs attract investors with greater liquidity demands than mutual funds (Chordia, 1996; Dannhauser and Hoseinzade, 2021). In March 2020, amid rising uncertainty from the COVID-19 pandemic, financial markets experienced a severe liquidity shock. Municipal bonds, which already suffer from low liquidity under normal conditions (Bagley et al., 2022; Griffin et al., 2023), became even harder to sell due to deteriorating dealer participation and limited market depth. The fragmented nature of the municipal bond market, marked by a high number of issuers and securities, further constrained liquidity.[6] In contrast, Muni ETFs trade on exchanges with continuous pricing and relatively low transaction costs, allowing investors to liquidate positions quickly. As a result, selling pressure became concentrated in ETFs, intensifying price pressures in the secondary market for ETF shares.

Because ETFs trade intraday while their underlying municipal bonds do not, large

[3] https://www.breckinridge.com/insights/details/considering-the-municipal-bond-market-implications-of-etf-asset-growth/.

[4] https://s24.q4cdn.com/856567660/files/doc_presentations/2023/BlackRock-2023-Investor-Day.pdf

[5] https://www.sec.gov/comments/credit-market-interconnectedness/cll10-8026117-225527.pdf

[6] https://www.msrb.org/sites/default/files/MSRB-Dealer-Participation-and-Concentration-Report.pdf

secondary-market sales of ETF shares can cause ETF prices to fall rapidly. Meanwhile, the NAVs of ETFs—calculated based on the estimated prices of underlying bonds—adjust more slowly due to limited bond market activity. This lag can cause ETF prices to trade at significant discounts to NAV during crises (Shim and Todorov, 2021). For example, starting around March 10, 2020, the market prices of MUB and VTEB began to diverge sharply from their indicative NAVs. On March 18, MUB traded at a 5.9% discount, while VTEB reached a 9.4% discount on March 19.[7] These deviations persisted well beyond the immediate onset of the crisis, suggesting that price misalignments were not rapidly corrected.

In theory, ETF arbitrage should eliminate such price-NAV gaps. When ETFs trade at a discount, APs can purchase ETF shares on the open market, redeem them with the ETF sponsors in exchange for the underlying bonds, and profit from the difference. Similarly, when ETFs trade at a premium, APs can deliver a basket of bonds to the sponsor in exchange for ETF shares, which are then sold in the market. This arbitrage activity keeps ETF prices aligned with NAV under normal conditions (Dannhauser, 2017).

However, the functioning of this mechanism relies on APs' ability to trade the underlying securities at low cost. During the COVID-19 crisis, multiple frictions may have prevented this. First, the municipal bond market became severely illiquid. Dealers reduced their inventories and bid-ask spreads widened, making it difficult for APs to source or liquidate bonds cost-effectively (Li et al., 2023). From Q1 2018 to Q3 2020, dealers had already reduced their muni bond inventories by 62% (Bagley et al., 2021), weakening the backstop liquidity that APs often rely on. Second, APs may have distrusted NAVs as stale or non-representative of true market values, which would limit their incentive to arbitrage.

Despite some industry commentary suggesting that APs remained active during the crisis,[8] the persistence and magnitude of NAV discounts imply that arbitrage was either constrained or not occurring at a sufficient scale to restore pricing parity.

[7] https://www.msrb.org/sites/default/files/Municipal-Bond-ETFs-During-COVID-19.pdf
[8] https://www.ici.org/doc-server/pdf:20_rpt_covid2.pdf

2.3 COVID-19 and Fed Interventions

The COVID-19 crisis presents a unique natural experiment to study ETF behavior under stress. Unlike previous disruptions—such as the 2013 Taper Tantrum—the Muni ETF market had grown large enough by 2020 to generate observable systemic patterns. In addition, financial regulations implemented in the post-2008 period had already eroded dealer capacity to act as liquidity providers. This left APs with limited ability to offload large bond baskets in a stressed market environment (Bessembinder et al., 2018). The recovery in the municipal bond market also lagged the corporate bond market, prolonging pricing disruptions (Wu and Burns, 2018).

These features make the COVID period an ideal setting to examine the conditions under which ETF arbitrage fails and whether persistent price dislocations emerge in less liquid markets.

During March and April 2020, the Federal Reserve implemented a series of extraordinary measures to stabilize financial markets. These included expanding the eligibility of liquidity facilities to cover short-term municipal securities and, the establishment of the Municipal Liquidity Facility (MLF) on April 9. While the MLF did not directly support ETF markets, it provided a critical backstop to the broader municipal bond market by purchasing short-term notes from state and local governments. Whether these interventions effectively narrowed ETF price-NAV deviations and reduced selling pressure—thereby indirectly restoring pricing efficiency—remains an open question.

2.4 Hypotheses

Building on the institutional details and market dynamics described above, I develop the following hypotheses to guide the empirical analysis.

When liquidity demand surges during a crisis, ETF investors may sell shares to raise cash. Unlike mutual funds, ETFs do not redeem shares directly. Instead, ETF prices are set in secondary markets, and redemptions occur through in-kind transactions between the

ETF sponsor and APs. If ETF prices fall below the NAV of the underlying bonds, APs are expected to arbitrage by buying discounted ETF shares, redeeming them for the underlying bonds, and selling those bonds in the market, thereby narrowing the price gap. However, APs might utilize discretion by allowing ETFs to trade at significant discounst for extended periods (Dannhauser and Hoseinzade, 2021).

Hypothesis 1 (ETF Price Dislocation): *During periods of market stress, municipal bond ETF prices deviate significantly below their NAVs.*

Alternative Hypothesis 1A: *Despite market stress, ETF prices remain closely aligned with NAV due to functioning arbitrage or limited liquidity pressure.*

A natural follow-up question is whether ETF arbitrage was functioning during the crisis. When ETF prices deviate meaningfully below NAV, APs should have incentives to exploit this gap through redemptions and municipal bond sales, which would show up as increases in institutional-sized trades of the underlying bonds (Holden and Nam, 2024). However, in stressed market conditions, APs may be unwilling to absorb baskets of illiquid municipal bonds onto their balance sheets or facilitate client redemptions through in-kind mechanisms (Finnerty et al., 2024). At the same time, the transparency and daily pricing provided by ETFs may lead to increased trading in the small-trade-size segment, even as large-scale arbitrage activity remains subdued (Doan, 2020).

Hypothesis 2 (Arbitrage Channel via Large-Trade-Size Activity): *If arbitrage mechanisms function properly, ETF price dislocations should trigger increases in large-trade-size activity in the underlying bonds.*

Alternative Hypothesis 2A: *If arbitrage is impaired—due to bond illiquidity or other market frictions—there should be little to no increase in large-trade-size trading.*

If arbitrage fails through the Muni ETF mechanism, one potential reason for failed arbitrage is the withdrawal of dealer liquidity. In mutual funds, redemptions require direct bond sales by the fund manager, often at depressed prices, regardless of market depth (Li et al., 2023). In contrast, ETFs rely on APs to redeem shares through in-kind transactions, which require offloading bonds into the secondary market. If dealers pulled back from absorbing or warehousing municipal bonds during the crisis, APs faced limited exit opportunities. Without dealer support, even when ETF prices fell below NAV, APs may have been unable or unwilling to execute arbitrage, allowing dislocations to persist.

Hypothesis 3 (Dealer Withdrawal): *Dealers provide less liquidity support for ETF-held bonds during the crisis, weakening arbitrage incentives.*

Alternative Hypothesis 3A: *Dealers continue to intermediate ETF-held bonds similarly to mutual fund-held bonds, enabling arbitrage to proceed.*

Beyond dealer behavior, market-wide frictions may also play a role. If trading costs for ETF-held bonds spiked relative to other bonds, APs may have been further disincentivized from engaging in arbitrage. While prior research by Dannhauser (2017) finds that ETF ownership can improve corporate bond liquidity, it remains unclear whether this liquidity benefit holds in the more fragmented municipal bond market under stress. Moreover, Fulkerson et al. (2017) suggests that liquidity costs create a barrier to arbitrage that allows some premiums and discouns to persist for bond ETFs.

Hypothesis 4 (Liquidity Frictions and Trading Costs): *Bid-ask spreads for ETF-held bonds widen during the crisis, reflecting increased trading frictions and discouraging arbitrage activity.*

Alternative Hypothesis 4A: *Trading costs remain stable across bond types, suggesting ETF price dislocations stem from other mechanisms.*

Lastly, during the COVID-19 crisis, the Federal Reserve introduced a series of interventions aimed at stabilizing financial markets and restoring investor confidence. However, these measures were rolled out in stages and did not initially provide comprehensive support to the municipal bond sector. On March 20, 2020, the Fed expanded the eligibility criteria for the Money Market Mutual Fund Liquidity Facility (MMLF) to include certain short-term municipal securities such as variable-rate demand notes (VRDNs). While this marked a step toward broader support, it was limited in scope and did not directly address the wider dislocations in the municipal bond market. It was not until April 9, 2020, that the Fed launched the Municipal Liquidity Facility (MLF), a targeted program offering a direct backstop for newly issued short-term municipal debt. Although the MLF did not explicitly include municipal bond ETFs or existing secondary-market bonds, it signaled a strong federal commitment to supporting the muni sector. To assess whether these interventions helped restore trading conditions and confidence in ETF-held bonds, I propose the following hypothesis:

Hypothesis 5 (Policy Intervention and Recovery): *Segment-specific interventions—such as the Municipal Liquidity Facility (MLF)—are more effective at restoring trading and liquidity in ETF-held bonds than broad-based measures.*

Alternative Hypothesis 5A: *Both broad and segment-specific policy actions have limited impacts on trading and pricing recovery.*

3 Data Sources, Sample Construction, and Variable Definitions

3.1 Data Sources and Sample Construction

This study integrates multiple data sources to construct a bond-day panel dataset of municipal bond trading activity and ownership structure during the COVID-19 market turmoil.

To identify municipal bond ETFs, I begin with the CRSP Survivor-Bias-Free US Mutual Fund Database, a comprehensive dataset covering U.S. mutual funds and ETFs, including their characteristics and holdings. Muni ETFs are defined as funds that meet all of the following criteria: (1) have a CRSP objective code of IU (fixed income, municipal), (2) are flagged as ETFs, (3) are assigned a Lipper objective indicating investment in municipal securities, and (4) possess a Lipper asset code corresponding to tax-exempt income funds. I exclude funds of funds from the analysis. To ensure accuracy in classification, I validate the initial CRSP-based ETF list using external sources including ETF.com, VettaFi, Refinitiv Eikon, fund fact sheets, and fund prospectuses.

Monthly fund holdings are primarily sourced from CRSP, and I supplement missing data using Refinitiv Eikon's portfolio disclosures. Most funds report holdings monthly on CRSP Mutual Fund Database. If holdings are unavailable for a given month, I carry forward the most recent available data to ensure continuity. I use these holdings to construct bond-level indicators for whether a bond is held only by ETFs, mutual funds, or both.

Municipal bond transaction data is obtained from the MSRB (Municipal Securities Rulemaking Board) RTRS database, which provides comprehensive over-the-counter trade records for all municipal securities. I exclude interdealer trades and clean the data following standard procedures in the literature (e.g., Green et al., 2010; Li and Schürhoff, 2019). This includes filtering out trades occurring within three months of issuance or within one year of maturity. Each trade includes information on par amount, trade size, date, and buyer/seller classifications.

Bond-level characteristics are merged from Refinitiv Eikon using nine-digit CUSIP identifiers. These variables include credit rating, tax status, insurance status, state of issuance, and features such as callability, sinkability, bank qualification, and AMT exposure.

The final sample spans from October 2019 to September 2020, covering the one-year window surrounding the COVID-19 crisis. The crisis period is defined as March 9 to March 20, 2020, corresponding to the acute phase of dislocation in the municipal bond market. This definition follows Li et al. (2023) and is supported by observed surges in ETF discounts, trading volumes, and mutual fund outflows during this period. Robustness checks using alternative windows (e.g., a three-week crisis definition) are provided in Section 6.

Merging trade records with monthly holdings and bond characteristics results in a bond-day level panel dataset with detailed information on trading activity, ownership classification, and bond fundamentals. Bonds are categorized into mutually exclusive groups: held exclusively by ETFs (*Only ETF*), held exclusively by mutual funds (*Only MF*), or held by both types of funds (*Both*). These classifications are used throughout the empirical analysis.

3.2 Descriptive Statistics

This section provides descriptive evidence that frames the central analysis by highlighting key differences between ETFs and mutual funds in terms of fund characteristics, holdings, and trading patterns.

Panel A of Table 1 presents the descriptive statistics for the Muni ETFs' growth. The sample includes Muni ETFs and Muni MFs and spans the period from October 2019 to September 2020, providing insights into both the number of funds and their characteristics over time. In Panel A, I examine the Number of ETFs and MFs by Year with AUM, showing the growth in both the number of ETFs and MFs in the market, alongside their total AUM. Over the observed period, the number of Muni ETFs increased from 59 in December 2019 to 86 by December 2023. During the same period, the total AUM of these ETFs rose from \$47.646 billion to \$122.272 billion. This growth contrasts with the relatively stable number of Muni MFs, which decreased slightly in number.

Panel B of Table 1 presents summary statistics for all active Muni ETFs during the one-year period surrounding the COVID-19 turmoil (October 2019 to September 2020). Based on the 59 funds that were outstanding during the sample period, the Muni ETF market demonstrates a wide variety of characteristics. On average, these funds have been in operation for approximately 4.88 years, with AUM totaling \$797.27 million. Approximately 97.22% of the assets in these funds are invested in municipal bond markets. The underlying bonds exhibit a mean weighted average maturity of 12.16 years. The average expense ratio stands at 0.26%, and the average turnover ratio is 33.79%.

Panel A of Table 2 shows that ETFs hold a narrower slice of the municipal bond universe compared to mutual funds, though the number of ETF-held bonds has grown alongside the expansion of the ETF market. Panel B highlights that trades in ETF-held bonds are disproportionately small in size: 84.5% of trades in ETF-only bonds fall below the $100,000 par value threshold, compared to 70.9% for bonds held only by mutual funds. This pattern might suggest greater retail activity in ETF-linked bonds. Combined with lower trade counts and smaller average trade sizes, these characteristics indicate that ETF-held bonds are more exposed to sentiment-driven retail flows—posing challenges for APs managing in-kind redemptions and arbitrage under market stress.

Finally, Panel C of Table 2 compares bond characteristics across fund holdings. ETF-held bonds are generally held in smaller proportions than MF-held bonds, with ETFs holding just 6.6% on average compared to 51.3% for mutual funds. These bonds also tend to have shorter maturities (6.4 vs. 10.7 years), lower chances to be insured (5% vs. 14%), and a lower likelihood of being callable (36% vs. 67%). While such characteristics may facilitate more flexible packaging for redemptions, whether they facilitate the ETF mechanism during market turmoil is unknown.

4 Price Dislocation and Market Stress: Descriptive Evidence

This section provides descriptive evidence on the performance of municipal bond ETFs during the COVID-19 crisis, focusing on the magnitude and persistence of price deviations from NAV. The patterns documented here support Hypothesis 1, which posits that Muni ETFs experienced unusually large and persistent NAV discounts due to structural frictions and illiquidity in the underlying municipal bond market.

Figure 1 illustrates key indicators of market stress. Panel A shows a sharp increase in cross-sectional volatility of Muni ETF returns in mid-March 2020, coinciding with peak market uncertainty. Panel B displays a concurrent drop in NAVs, reflecting a decline in the value of underlying municipal bonds during the turmoil.

To benchmark the severity of price dislocations, Figure 2 compares average ETF price deviations across four asset classes—municipal bonds (IU), corporate bonds (IC), government bonds (IG), and domestic equities (ED)—as defined by CRSP style codes. Muni ETFs exhibit the largest and most persistent NAV discounts, with dislocations exceeding 5% and remaining elevated well into April. By contrast, other bond and equity ETFs saw smaller and more short-lived mispricings. These results highlight that NAV misalignment was particularly acute in the municipal bond sector, suggesting ETF pricing mechanisms were more vulnerable in illiquid markets.

Together, these stylized facts underscore the exceptional nature of Muni ETF pricing dislocations during the COVID-19 crisis. This motivates the analysis in Section 5, which investigates the causes of the sharp dislocation and examines whether impaired arbitrage and bond-level trading frictions explain the persistence of these deviations.

5 Mechanism Analysis

5.1 Price Dislocation and Bond Trading Activity

Persistent ETF price dislocations during the COVID-19 crisis raise a natural question: did investors' responses in the secondary ETF market translate into increased trading in the underlying municipal bonds? If APs were redeeming ETF shares and offloading bonds to arbitrage and close the deviation between ETF price and NAV, then we would expect to see higher bond-level trading activity for ETF-held bonds during the turmoil (Cotelioglu, 2024).

To evaluate this, I employ a difference-in-differences (DiD) framework using bond-level trade data. I classify municipal bonds into four mutually exclusive groups based on their fund ownership structure as of February 2020: (1) held only by ETFs, (2) held only by mutual funds (MFs), (3) held by both ETFs and MFs, and (4) not held by either. I estimate the following baseline regression model:

$$
\begin{aligned}
Trading\ Volume_{i,t} = \alpha + \beta_1 * Crisis_t + \beta_2 * Only\ by\ ETF_i + \beta_3 * Only\ by\ ETF_i * Crisis_t \\
+\beta_4 * Only\ by\ MF_i + \beta_5 * Only\ by\ MF_i * Crisis_t + \beta_6 * Both_i + \beta_7 * Both_i * Crisis_t \\
+\beta_8 * Controls_{i,t} + \text{Fixed Effects} + \epsilon_{i,t}
\end{aligned} \tag{1}
$$

The dependent variable is municipal bond trading activity, measured in two ways: the natural logarithm of total daily par value traded (*Log Sum Par*) and the number of trades per bond per day. The key coefficient of interest, β_3, identifies whether bonds held exclusively by ETFs experienced heightened trading activity during the COVID turmoil period (March 9 to March 23, 2020), relative to bonds not held by any funds. Control variables include bond characteristics (issue size, maturity, age, coupon rate, guarantee status, insurance, tax status), and a set of fixed effects for date, rating, bond type, embedded options, and issuing state.

Figure 3 (Panels A and B) and **Table 3** present the results. I find a statistically significant increase in trading activity for bonds held exclusively by ETFs during the crisis period. This holds across both measures: the par value traded and the number of trades. The magnitude of the trading increase is comparable to that observed for bonds not held by funds, suggesting that ETF ownership was associated with heightened bond turnover during market stress.

These patterns are also visually supported in Figure 3, which shows sharp increases in both the total par traded (Panel A) and trade counts (Panel B) for ETF- and MF-held bonds during the turmoil window. While this confirms that ETF-linked bonds were more actively traded during the COVID crisis, this alone does not demonstrate that ETF arbitrage was functioning. To assess whether the trading activity is consistent with arbitrage behavior, I next disaggregate transactions by trade size to distinguish between large- and small-trade-size segments.

5.2 Trade Size Segments: Unpacking Trading Volume Shifts

To better understand whether ETF arbitrage activity contributes to increased trading volume in the underlying municipal bond market, I disaggregate transactions by trade size. The ETF arbitrage mechanism—where APs create or redeem ETF shares to exploit price differences with the NAV—is executed almost exclusively by large-scale transactions, as APs possess the scale and access necessary for in-kind transactions.

Therefore, if arbitrage was active during the crisis period, we would expect to observe a rise in large-trade-size activity in ETF-held bonds. Conversely, an absence of such a pattern would suggest that arbitrage failed to materialize. This distinction is well documented in the literature: Ben-David et al. (2018) emphasize that ETF arbitrage relies heavily on large-scale trades to close price-NAV gaps, and Dannhauser (2017) shows that block trades increase alongside ETF flows when arbitrage is functioning. Guided by these insights, I partition the trading volume into large-trade-size ($\geq$ \$100,000 par value) and small-trade-size ($<$ \$100,000) segments,[9] and estimate the effects of COVID-induced stress on each category separately.

Table 4 presents the regression results for large-trade-size activity. The coefficients for the interaction between the crisis period and bonds held exclusively by ETFs are statistically insignificant across all specifications. This indicates that, despite the sharp increase in ETF share selling during the crisis, there was no corresponding increase in institutional trading volume in the underlying bonds. In contrast, mutual-fund-held bonds do exhibit a statistically significant increase in large-trade-size during the same period, consistent with mutual funds needing to sell underlying assets to meet redemption demands. These findings suggest that ETF arbitrage activity was largely inactive during the COVID turmoil.

In contrast, the results in Table 5 demonstrate a different pattern for small-trade-size activity. Bonds held exclusively by ETFs show a statistically significant increase in both

[9] This threshold follows common practice in the bond and ETF literature (e.g., Ben-David et al., 2018) as a proxy for trade scale. However, it does not perfectly distinguish between institutional and retail investors. Institutions may also execute small trades, and some large trades may be placed by non-institutional actors. I interpret the results accordingly as reflecting trade size segments rather than definitive investor types.

trading volume (log par traded) and number of trades during the crisis period. This suggests that the surge in trading volume in ETF-held bonds was concentrated in smaller-sized transactions, rather than large-scale redemptions. Such patterns are consistent with liquidity-seeking behavior or reactive trading during market stress.

Taken together, the evidence in this section reinforces the conclusion that the ETF arbitrage mechanism remained largely dormant during the COVID crisis. Trading activity in the large-trade-size segment of ETF-held bonds was limited, even as NAV deviations widened. Instead, most of the trading response was concentrated in smaller-sized trades, which may have reflected decentralized or sentiment-driven actions. These patterns help explain why ETF prices deviated significantly and persistently from NAV: in the absence of robust arbitrage activity, misalignments were left to persist in the secondary market.

5.3 Fund Flow and Trading Volume Transmission

The previous analysis shows that ETF-held municipal bonds experienced increased trading activity during the COVID-19 crisis, particularly in the small-trade-size segment, while large-trade-size activity—typically associated with ETF arbitrage—remained limited. To further explore the functioning of the arbitrage mechanism, this section relates fund outflows to underlying bond-level trading volume.

First, if arbitrage was occurring, even to a limited extent, APs would need to redeem ETF shares and offload the underlying bonds, leaving a footprint in trading volume. Second, such selling—if present—could amplify liquidity stress for ETF-held bonds during crises, posing risks to bondholders. Third, comparing this dynamic to mutual funds offers insight into how fund structure shapes market impact under stress. In this way, fund flow analysis provides an additional layer of evidence for understanding the persistence of ETF price deviations.

To empirically assess this, I construct a bond-level measure of fund outflows following

Dannhauser and Hoseinzade (2021), calculated as:

$$\text{Fund Flow}_i = \frac{\sum(\text{Holding Amount}_{i,k} \times \text{Outflow}_{k,t-1,t})}{\sum \text{Holding Amount}_{i,k}}$$

where Holding $\text{Amount}_{i,k}$ is the par value of bond i held by fund k as of February 2020, and $\text{Outflow}_{k,t-1,t}$ represents the one-day percentage outflow from fund k, net of fund-level returns (Fulkerson et al., 2017). This variable captures how much flow pressure a bond is exposed to based on its presence in portfolios undergoing outflows.

Using this variable, I estimate the following regression:

$$\begin{aligned} Trading\ Volume_{i,t} = \alpha + \beta_1 \cdot \text{Fund Flow}_{i,t} + \beta_2 \cdot \text{Total Share}_i + \gamma' X_{i,t} \\ + \text{FE}_{\text{Date, Rating, Type, Option, State}} + \epsilon_{i,t} \end{aligned} \tag{2}$$

where the dependent variable is the natural log of daily par value traded for bond i on day t. Total Share_i controls for each bond's ownership share across ETFs or mutual funds, and $X_{i,t}$ includes other bond-level characteristics (issue size, maturity, age, coupon rate, etc.).

The results in Table 6 offer several insights. First, mutual fund outflows are positively and significantly associated with trading volume in their portfolio bonds, confirming that mutual fund redemptions directly transmit liquidity pressure to the underlying market. This effect is strongest among bonds held exclusively by mutual funds. In contrast, ETF outflows do not exhibit a statistically significant relationship with bond trading volume. This finding suggests that the ETF structure shielded underlying bonds from forced liquidation during market turmoil, as investor selling was absorbed primarily through secondary-market trading of ETF shares rather than redemptions via AP arbitrage.

Taken together, these results reinforce the notion that ETF outflows—despite contributing to large and persistent NAV deviations—did not translate into forced bond sales. Instead, the ETF arbitrage mechanism remained inactive, and APs did not serve as conduits for transmitting redemption pressure to the underlying muni bond market.

5.4 Dealer Behavior During Market Stress

Previous sections have shown that municipal bond ETFs experienced persistent price dislocations during the COVID-19 crisis, with little evidence of institutional arbitrage activity or bond-level trading volume tied to AP arbitrage. One potential explanation for the apparent breakdown in the ETF arbitrage mechanism lies in dealer behavior. Specifically, dealers may have been reluctant to intermediate ETF-related flows due to increased risk aversion, reduced balance sheet capacity, and elevated trading frictions during the crisis. This subsection investigates whether bonds held by ETFs received different levels of dealer support compared to mutual fund-held bonds or bonds held by both fund types.

To evaluate this, I analyze dealers' net purchases of municipal bonds around the COVID-19 market turmoil. The key variable of interest, *Dealer Net Purchase*, is defined as the difference between dealers' aggregate purchases from customers and aggregate sales to customers for a given bond on each trading day. If dealers were willing to absorb liquidity pressure, particularly for ETF-held bonds, one would expect to see an increase in net purchases during the crisis.

The regression results are presented in Table 7. The sample spans February 24 to March 20, 2020, and the crisis window is defined from March 9 to March 20. The estimates reveal a notable asymmetry in dealer behavior depending on fund holding structure. For bonds held *only by ETFs*, the interaction term *Crisis* $\times$ *Only by ETF* is negative and statistically significant, suggesting that dealers withdrew support from these bonds during the crisis. In contrast, bonds held *only by mutual funds* experienced an increase in dealer net purchases.

These findings indicate that dealers were less willing to provide liquidity for ETF-held municipal bonds during the crisis. This reduction likely constrained the ETF arbitrage mechanism, as APs—who depend on dealers to offload redeemed bonds—faced greater execution frictions. In contrast, mutual funds, which are obligated to sell bonds to meet redemptions, may have been more tolerant of higher trading costs and continued to receive dealer support even amid market stress.

Overall, this analysis provides additional evidence that structural frictions in the municipal bond market—especially limited dealer capacity and market fragmentation—contributed to the persistence of ETF price dislocations. The reduced willingness of dealers to intermediate ETF-related flows during stress further underscores the fragility of the arbitrage mechanism in illiquid bond markets.

5.5 Bond Liquidity

This subsection examines whether the structural frictions identified earlier—muted arbitrage, reduced dealer support, and increased trading in smaller-size transactions—contributed to elevated trading costs for ETF-held bonds during the COVID-19 crisis. While prior research by Dannhauser (2017) finds that ETF ownership can improve corporate bond liquidity, it remains unclear whether this liquidity benefit holds in the more fragmented municipal bond market under stress. Fulkerson et al. (2017) suggests that liquidity costs create a barrier to arbitrage that allows some premiums and discouns to persist for bond ETFs. If trading costs were significantly higher for ETF-related bonds, this would further discourage APs from engaging in arbitrage and help explain the persistence of NAV deviations. The central question is whether ETF-held muni bonds experienced greater liquidity deterioration—adding another layer of friction to the ETF mechanism—or if the ETF activity continued to benefit liquidity even during turmoil.

To assess the consequences of these structural frictions, I examine bond-level bid-ask spreads—a widely used proxy for transaction costs and market liquidity—during the crisis. Using the same difference-in-differences specification, I re-estimate the baseline model from Equation 1, replacing trading volume with daily bid-ask spread as the dependent variable. The regressions are estimated separately for the large-trade-size (par value $\geq$ \$100,000) and small-trade-size (par value $<$ \$100,000) segments.

Table 8 reports the results. In the large-trade-size segment, there is no significant increase in trading costs for ETF-held bonds during the crisis period. This is consistent with earlier findings that trading activity in large-sized transactions remained subdued. In contrast, ETF-held bonds in the small-trade-size segment exhibit a sharp and statistically significant increase in bid-ask spreads during the COVID crisis. This suggests that the rise in smaller-sized transactions or missing dealer support—exposed ETF-held bonds to deteriorating liquidity conditions.

In contrast, MF-held bonds show no such deterioration. If anything, the estimates point to improved or stable liquidity during the crisis, likely reflecting more robust dealer engagement. These findings underscore that ETF ownership alone did not mechanically impair bond liquidity; rather, it was the combination of structural frictions in the ETF mechanism, market stress, and trading channel composition that amplified the efficiency of the arbitrage mechanism. Persistent NAV discounts documented earlier may thus reflect not just price dislocations, but also real frictions in bond-level liquidity driven by ETF structural constraints.

5.6 Federal Policy Intervention

In this section, I examine the resolution of the COVID turmoil to evaluate the effectiveness of policy interventions in restoring investor confidence. As outlined in Section 2.3, the Federal Reserve expanded the eligibility criteria for the Money Market Mutual Fund Liquidity Facility (MMLF) and the Commercial Paper Funding Facility (CPFF) on March 23 to include certain short-term municipal securities. Following this, on April 9, the Federal Reserve introduced the Municipal Liquidity Facility (MLF), a more targeted intervention aimed directly at the municipal bond market. These interventions were followed by noticeable improvements in municipal market conditions, with outflows from Muni ETFs subsiding, suggesting a positive market response to these actions.

To assess the impact of these interventions, I focus on the two-week recovery period following each announcement. Specifically, I examine the changes in trading volume and trading costs for municipal bonds in the two-week periods before and after the interventions.

By replacing the "Crisis" dummy with a "Post Crisis" dummy, I re-estimate model 1, and the results are presented in Table 9. The analysis reveals that while trading volume and costs showed some improvements following the March 23 intervention, these changes were only statistically significant after the April 9 MLF intervention. Specifically, the April 9 intervention led to a significant reduction in trading costs and trading volume. This suggests that segment-specific interventions, such as the MLF, were more effective in restoring market confidence and stabilizing the municipal bond market during the crisis.

6 Robustness Checks

This section conducts several robustness tests to examine whether the main results are sensitive to modeling choices. I consider an alternative sample that includes non-traded bonds, test a longer crisis window, and replace fund holding dummies with continuous ownership shares. The results remain consistent, suggesting that the key patterns identified in the baseline analysis are not driven by sample selection or specification choices.

6.1 Balanced Sample Test

A concern in the baseline specification is potential selection bias, since it only includes bonds that were traded during the COVID period. To address this, I construct a balanced sample of all outstanding municipal bonds between February 24 and March 20, 2020—including those that did not trade—and assign zero trading volume to non-traded bonds.

As shown in Table IA1, the results remain consistent. Bonds held by ETFs or by both ETFs and MFs experienced significantly higher increases in trading volume and number of trades relative to non-held bonds. The *Crisis* interaction coefficients are also positive and statistically significant for ETF-held bonds, confirming that the surge in ETF-related trading is not driven by selection bias.

6.2 Alternative COVID Crisis Window

To ensure the findings are not sensitive to the specific COVID window definition, I adopt an alternative specification following Haddad et al. (2021). This extends the crisis period to cover March 2 through March 20, 2020, and includes a longer pre-crisis window from February 10 onward.

Table IA2 reports the results. The pattern of elevated trading activity in ETF-held bonds during the extended crisis period holds robustly, particularly in the small-trade-size segment. The estimates for *Crisis * Only ETF* and *Crisis * Both* remain positive and statistically significant, reinforcing the paper's claim that ETF-held bonds experienced distinctive trading responses under market stress.

6.3 Using Fund Ownership Shares

In the baseline analysis, fund ownership is captured via categorical dummy variables. A more granular specification involves using continuous ownership shares—defined as the percentage of a bond's par value held by ETFs, MFs, or both.

Tables IA3 and IA4 present the regression results for trading volume and trading costs, respectively. The findings remain qualitatively consistent. Trading volume in the small-trade-size segment increases significantly with higher ETF ownership during the crisis, while volume in the large-trade-size segment shows no response. Similarly, liquidity deteriorates more for small-sized trades of ETF-held bonds, as reflected in significant increases in trading costs. These effects are not observed for bonds held by mutual funds.

Altogether, these robustness checks strengthen the conclusion that ETF-related frictions—particularly those associated with increased small-sized trading and limited dealer intermediation—amplified pricing dislocations during the COVID crisis.

7 Conclusion

This paper examines the Muni ETFs behavior during the COVID-19 crisis. I find that ETF share prices deviated significantly and persistently from their NAVs during the period of market turmoil. Although the ETF structure is designed to support pricing efficiency through the creation and redemption process, this mechanism did not function effectively during the crisis. Specifically, ETF-held bonds did not exhibit increased trading volume in the large-trade-size segment, suggesting that authorized participants may have refrained from engaging in arbitrage activity. In contrast, trading activity in smaller-sized transactions increased substantially for ETF-held bonds, indicating a concentration of market responses in lower-scale trade segments.

Meanwhile, bonds held by municipal mutual funds experienced larger increases in overall trading volume, consistent with redemption-driven selling pressures. These findings suggest that while ETFs may shield the underlying bond market from direct fire sales, they might expose investors to persistent pricing dislocations and the risk of transacting at steep discounts to NAV. The results highlight how structural frictions can impair ETF pricing in fragmented, illiquid markets like municipals.

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Appendix A

Variable Definitions

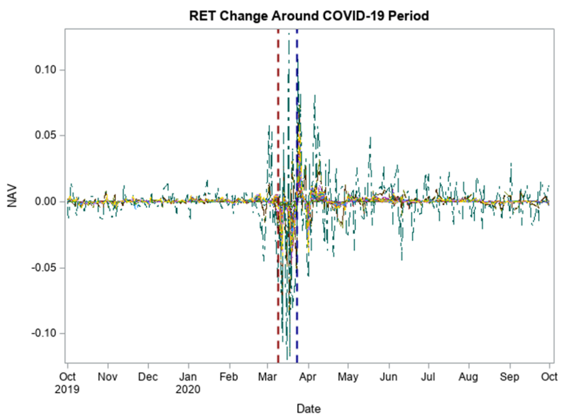
Variable	**Definition**	**Source**
Event Indicators and Time Variables		
Crisis	Equals 1 if the observation falls within the COVID crisis period (March 9 to March 20, 2020), and 0 otherwise.	MSRB
Post-Crisis	Equals 1 if the observation falls within the two-week period after a Federal Reserve intervention (e.g., March 23 or April 9), and 0 otherwise.	MSRB
Date	Calendar trading date for each bond-day observation.	MSRB
Fund Ownership and Flow Variables		
Only ETF	Equals 1 if the bond is held exclusively by ETFs and 0 otherwise.	CRSP
Only MF	Equals 1 if the bond is held exclusively by mutual funds and 0 otherwise.	CRSP
Both	Equals 1 if the bond is held by both ETFs and mutual funds.	CRSP
ETF Share	Percentage of the bond held by ETFs as a share of its total market value.	CRSP
MF Share	Percentage of the bond held by mutual funds as a share of its total market value.	CRSP
Both Share/ Total Share	Percentage of the bond held jointly by ETFs and mutual funds.	CRSP
Fund Flow	Weighted average of fund outflows for each bond.	CRSP
Trading Outcome Variables		
Log Sum Par	Natural logarithm of the total par amount traded for a bond on a given day.	MSRB
No. of Trades	Count of all trades in a bond on a given day.	MSRB
Trading Cost	Bid-ask spread calculated as the difference between the weighted average purchase price and sale price.	MSRB
Dealer Net Purchase	Net par amount bought by dealers (purchases from customers minus sales to customers).	MSRB
Bond Characteristics		

Issue Size	Log of original par amount issued for the bond.	Eikon
State	State of the bond issuer.	Eikon
Maturity	Remaining time to maturity, measured in years.	Eikon
Age	Time since issuance, measured in years.	Eikon
Coupon Rate	The stated annual interest rate on the bond.	Eikon
AMT	Equals 1 if the bond is subject to the Alternative Minimum Tax (AMT), and 0 otherwise.	Eikon
Bank Qualified	Equals 1 if the bond qualifies for tax benefits for banks, and 0 otherwise.	Eikon
Insured	Equals 1 if the bond carries insurance from a guarantor, and 0 otherwise.	Eikon
Is Guaranteed	Equals 1 if the bond's payments are guaranteed by a third party.	Eikon
Callable	Equals 1 if the bond is callable, and 0 otherwise.	Eikon
Puttable	Equals 1 if the bond is puttable, and 0 otherwise.	Eikon
Sinking Fund	Equals 1 if the bond includes a sinking fund provision, and 0 otherwise.	Eikon
General Obligation	Equals 1 if the bond is a general obligation bond backed by the issuer's taxing authority.	Eikon
Tax Status	Equals 1 if the bond is tax-exempt, and 0 if it is taxable. Based on Eikon's "Tax Status" code.	Eikon
Rating	Credit quality rank based on the "Rating Rank" field. Each rating is assigned a numerical value, with unrated bonds placed into a separate numerical category.	Eikon
Fund-Level Variables		
Net Asset Value (NAV)	Per-share value of the ETF's municipal bond holdings.	CRSP
Assets Under Management (AUM)	Total market value of assets managed by the ETF, including municipal bonds.	CRSP
Fund Age	Number of years since the ETF's inception, measured as of the observation date.	CRSP
Fund Average AUM	Average assets under management for the ETFs during the sample period, in millions of USD.	CRSP
Muni Allocation (%)	Percentage of total fund assets invested in municipal bonds.	CRSP
Weighted Average Maturity (Years)	Weighted average time to maturity of the fund's underlying municipal bonds.	CRSP

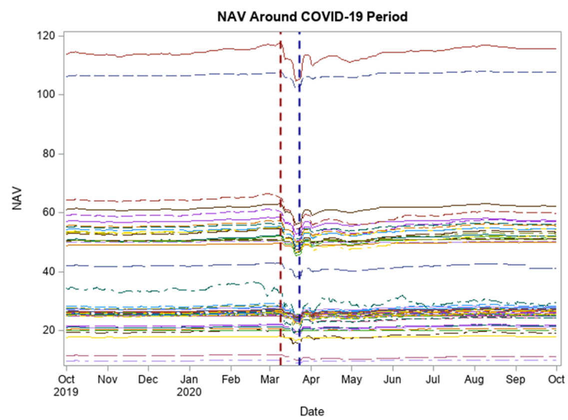
Expense Ratio (%)	Annualized operating expense of the fund, expressed as a percentage of AUM.	CRSP
Turnover Ratio (%)	Annual portfolio turnover, calculated as the lesser of purchases or sales divided by average AUM.	CRSP

Figure 1: **Key Measures of Municipal Bond ETFs During the COVID-19 Crisis**

This figure presents key indicators of municipal bond ETF market conditions during the COVID-19 crisis. Panel A reports the daily return volatility of Muni ETFs, calculated as the cross-sectional standard deviation of daily returns across all available Muni ETFs on each trading day; volatility spikes sharply in mid-March, signaling heightened uncertainty and market stress. Panel B plots the NAV of each active Muni ETF during the sample period. Two vertical lines mark the COVID-19 market turmoil window, from March 9 to March 23, 2020.



Panel A: Return Volatility



Panel B: NAV Trend

Figure 2: **Trends in ETF Price Deviations Across Categories During the COVID-19 Crisis**

This figure compares ETF price deviations across asset classes during the COVID-19 crisis. It presents the time series of average daily price deviations—measured as the difference between ETF market price and NAV—for four major ETF categories: municipal bond (IU), corporate bond (IC), government bond (IG), and domestic equity (ED), based on CRSP style codes. Muni ETFs exhibit the most severe and persistent dislocations, with deviations peaking during March 2020 and remaining elevated for an extended period. Two vertical lines mark the COVID-19 market turmoil window, from March 9 to March 23, 2020.

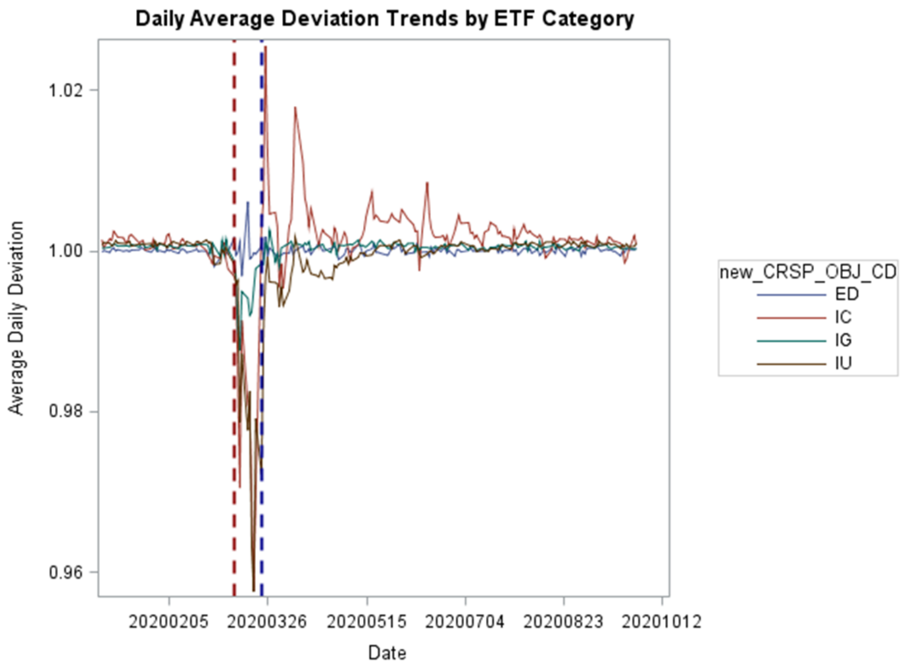
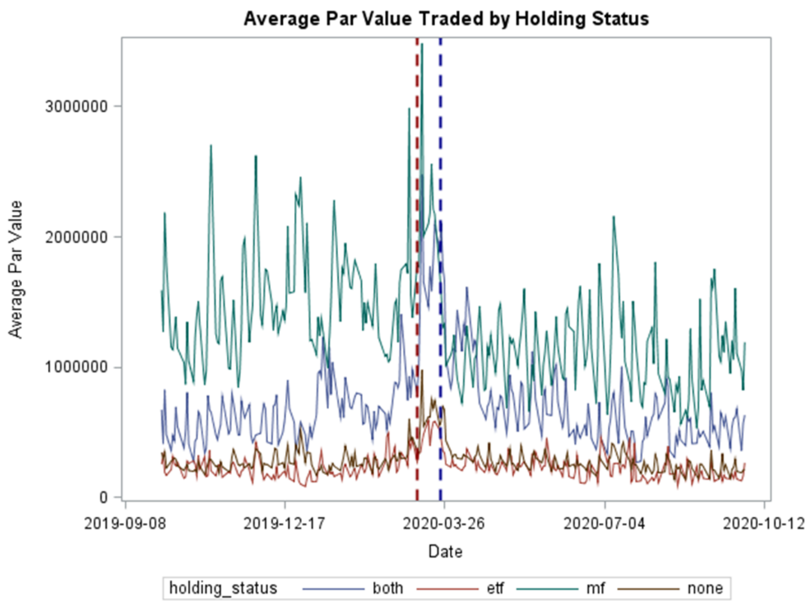
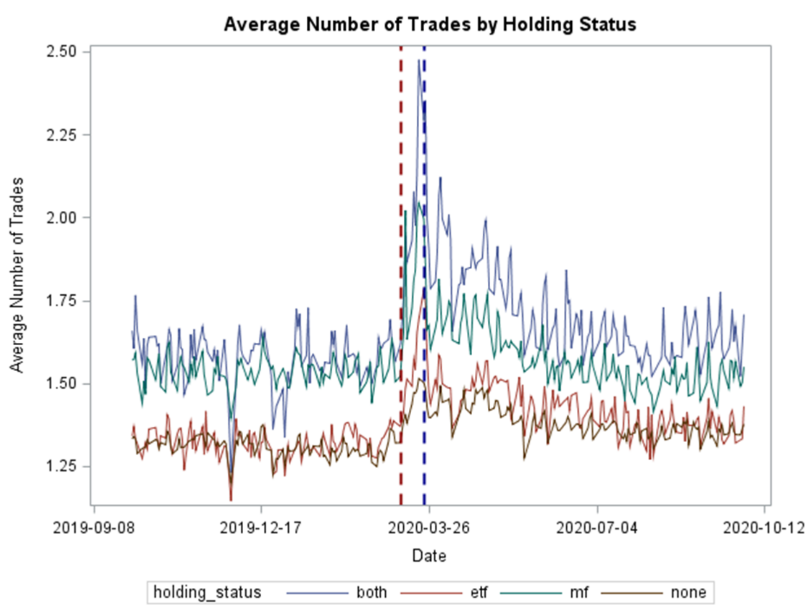


Figure 3: **Daily Trading Volume of Municipal Bonds by Fund Holdings During the COVID-19 Period**

This figure presents the trading dynamics of municipal bonds categorized by fund ownership: bonds held only by ETFs, only by mutual funds (MFs), by both ETFs and MFs, or by neither. Panel A shows the average daily total par value traded for each group from October 2019 to September 2020. Panel B displays the average daily number of trades by group over the same period. Two vertical lines mark the COVID-19 market turmoil window, from March 9 to March 23, 2020.



Panel A: Average Daily Par Value Traded by Fund Ownership



Panel B: Average Daily Number of Trades by Fund Ownership

Figure 4: **Trading Costs of Municipal Bonds by Fund Holding Status During the COVID-19 Period**

This figure compares the trading costs of municipal bonds based on their holding status: exclusively held by ETFs, exclusively held by MFs, held by both ETFs and MFs, and held by neither. Trading costs are measured using bid-ask spreads. Two vertical lines mark the COVID-19 market turmoil window, from March 9 to March 23, 2020.

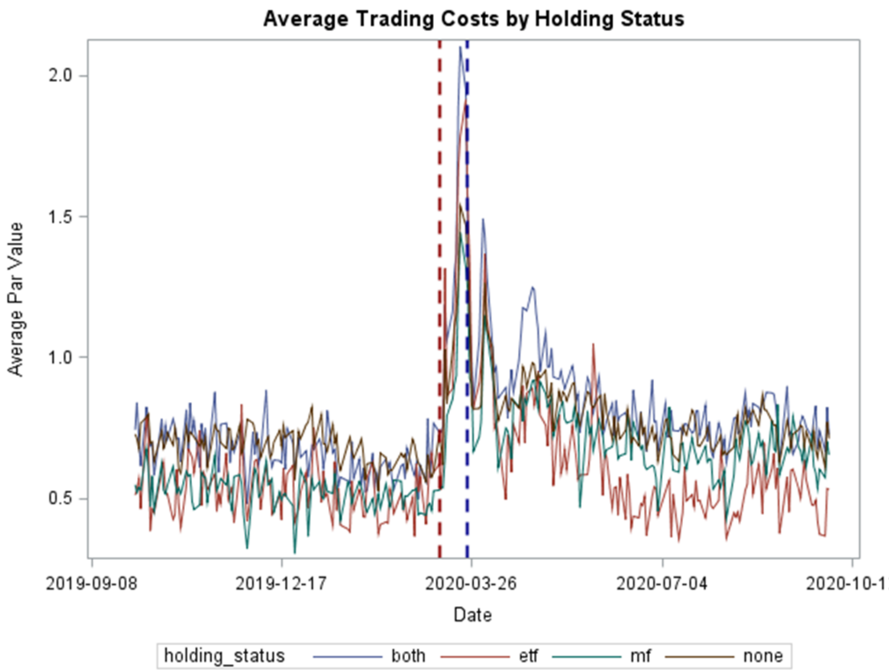


Table 1: Descriptive Table for Funds

This table presents summary statistics for municipal bond ETFs and mutual funds. **Panel A** shows the number of Muni ETFs and MFs and their total assets under management (AUM) at year-end from 2019 to 2023. **Panel B** summarizes key characteristics of the 59 Muni ETFs that were active during the sample period (October 2019 to September 2020). See Appendix A for detailed variable definitions and data sources.

Panel A: Number of ETFs and mutual funds by Year with AUM

Month	Number of ETF	Total AUM of ETF	Number of MF	Total AUM of MF
201912	59	47646	562	806434
202012	61	61941	560	870466
202112	69	82326	548	973001
202212	73	104049	550	741590
202312	86	122272	535	741797

Panel B: Summary Statistics for Municipal Bond ETFs

	Mean	Median	Standard Deviation	No. of ETFs
Fund Age	4.88	2.43	4.57	59
Fund Average AUM	797.27	79.2	2234.82	59
Amount of fund invested in Municipal Bonds (%)	97.22	98.81	14.65	59
Weighted Average Maturity in Years	12.16	11.9	5.81	59
Expense Ratio (%)	0.26	0.24	0.0012	59
Turnover Ratio (%)	33.79	15	0.4386	59

Table 2: Descriptive Table for Bonds

This table summarizes characteristics of municipal bonds held by ETFs and mutual funds, as well as bonds not held by either. **Panel A** reports the number of unique bonds held by ETFs and MFs at year-end from 2019 to 2023, distinguishing between bonds held by ETFs only, MFs only, or by both. **Panel B** describes trading activity across these ownership types, excluding March and April 2020. It includes total trade counts, investor type shares, daily trade counts, and average par value per trade. **Panel C** reports average bond characteristics by fund ownership type, including maturity, coupon, tax status, and structural features (e.g., callable, insured, guaranteed). Definitions and sources are provided in Appendix A.

Panel A: Number of Unique Fund-held Bonds

Month	MF-held Bond	ETF-held Bond	Held by Both	Only held by ETF	Only held by MF
201912	105309	25786	16437	9349	88872
202012	114142	31593	19346	12247	94796
202112	126801	40702	24351	16351	102450
202212	113125	34953	22971	11982	90154
202312	107705	36354	24949	11405	82756

Panel B: Trading Activity in Fund-held Bonds (without 202003 and 202004)

	Only held by ETF	Only held by MF	Held by Both	None	Total
Number of Trades	160621	661572	548289	1630247	3000729
% Number of Trades	5.35%	22.05%	18.27%	54.33%	100%
Small Trade Size %	84.52%	70.93%	78.81%	86.18%	81.38%
Large Trade Size %	15.48%	29.07%	21.19%	13.82%	18.62%
Average number of trades per day	769	3165	2623	7800	14358
Average par per trade	156029	821773	382290	191337	363330

Panel C: Bond Characteristics

	Only held by ETF	Only held by MF	Held by Both	None
Coupon	4.6	4.535	4.677	3.759
Age	4.547	4.329	4.376	4.17
Maturity	6.396	10.74	12.491	8.101
Share held by fund	0.066	0.513	0.522	0
AMT	0.003	0.046	0.024	0.009
Taxable	0	0.011	0	0.069
Is guaranteed	0.114	0.109	0.053	0.201
Insured	0.05	0.14	0.06	0.192
Bank Qualified	0.009	0.024	0.001	0.223
Sinkable	0.063	0.211	0.294	0.111
Putable	0.006	0.026	0.026	0.005
Callable	0.361	0.667	0.665	0.587
Face issued total	8,301,941.82	5,598,448.14	26,010,217.51	1,046,539.96
GO bond	0.384	0.384	0.249	0.474
Number of bonds	9328	67296	16406	451723

Table 3: Trading Volume During the COVID Crisis: Including Fund Holding Dummies

This table reports the results of a difference-in-differences regression analyzing changes in trading activity for municipal bonds during the COVID-19 turmoil, based on fund ownership structure. The sample includes bond-day observations from February 24 to March 20, 2020. The dependent variables are the natural logarithm of the bond's total daily par value traded (Log Sum Par) and the number of trades (No. of Trades). The key independent variables are interactions between a crisis period dummy (March 9–20) and bond ownership status as of February 2020: *Only by ETF*, *Only by MF*, and *Both* (held by both ETFs and MFs). The coefficient on *Crisis * Only ETF* captures the relative change in trading volume for bonds held exclusively by ETFs during the crisis period, compared to bonds not held by any funds. Control variables include bond characteristics (issue size, maturity, age, coupon), and indicators for whether a bond is guaranteed, insured, bank-qualified, or subject to the alternative minimum tax (AMT). Fixed effects are included for trade date, rating, bond type, embedded options, and issuing state. Variable definitions and data sources are detailed in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Log Sum Par (1)	No. of Trades (2)	Log Sum Par (3)	No. of Trades (4)	Log Sum Par (5)	No. of Trades (6)	Log Sum Par (7)	No. of Trades (8)
Only MF	0.148***	-0.0135	0.186***	0.0248				
	(5.20)	(-0.73)	(6.63)	(1.57)				
Crisis*Only MF	0.283***	0.119***	0.282***	0.110***				
	(6.71)	(3.70)	(6.78)	(3.72)				
Only ETF	-0.0779***	-0.0479***			-0.0601**	-0.0213*		
	(-2.68)	(-3.10)			(-2.04)	(-1.88)		
Crisis*Only ETF	0.0637**	0.0533***			0.0683**	0.0519***		
	(1.97)	(3.44)			(2.09)	(3.80)		
Both	-0.00834	-0.052					0.023	-0.028
	(-0.21)	(-1.72)					(0.59)	(-0.97)
Crisis*Both	0.333***	0.209***					0.332***	0.197***
	(7.28)	(4.44)					(7.17)	(4.38)
Issue size	0.254***	0.123***	0.226***	0.0838***	0.186***	0.0639***	0.234***	0.108***
	(17.41)	(11.47)	(16.85)	(10.71)	(16.93)	(11.86)	(17.15)	(10.97)
Maturity	-0.0491***	0.0217***	-0.0780***	0.0237***	-0.121***	0.00181	-0.0840***	0.0118*
	(-3.12)	(3.08)	(-4.78)	(4.34)	(-11.58)	(0.39)	(-6.46)	(1.79)
Age	-0.200***	-0.0332***	-0.162***	-0.0181***	-0.150***	-0.00887**	-0.199***	-0.0280***
	(-16.45)	(-4.55)	(-13.67)	(-2.98)	(-17.26)	(-2.27)	(-18.44)	(-4.15)
Coupon	-0.0395*	0.000159	-0.0369	0.000355	0.013	0.0053	-0.00378	0.00217
	(-1.81)	(0.02)	(-1.55)	(0.04)	(0.79)	(0.76)	(-0.22)	(0.31)
Is guaranteed	0.885***	0.139***	0.821***	0.107***	0.456***	0.0316*	0.611***	0.0723***
	(17.69)	(5.49)	(16.02)	(4.81)	(9.56)	(2.06)	(11.37)	(3.16)
Insured	-0.0829**	0.128***	-0.0704*	0.112***	0.0121	0.0797***	-0.0174	0.104***
	(-2.61)	(6.60)	(-2.03)	(5.96)	(0.36)	(5.37)	(-0.60)	(6.00)
Bank qualified	0.551***	0.108***	0.527***	0.0813***	0.529***	0.0711***	0.565***	0.107***
	(13.93)	(6.83)	(13.81)	(5.77)	(12.49)	(5.61)	(13.70)	(7.39)
AMT	0.446***	-0.0936***	0.460***	-0.0647**	0.366***	-0.0906**	0.524***	-0.0828**
	(6.89)	(-3.32)	(6.67)	(-2.29)	(4.25)	(-2.39)	(5.94)	(-2.20)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	7.243***	-0.546**	7.684***	0.0275	8.120***	0.333***	7.452***	-0.306*
	(22.17)	(-2.68)	(24.80)	(0.17)	(35.75)	(3.13)	(26.69)	(-1.75)
No. of observations	268843	268843	207570	207570	169125	169125	195660	195660
Adjusted R^2	0.326	0.12	0.369	0.107	0.268	0.049	0.273	0.109

Table 4: Trading Volume During the COVID Crisis (Large-Trade-Size Segment)

This table reports results from a difference-in-differences regression estimating the impact of COVID-19 turmoil on bond trading volume, focusing specifically on *large-trade-size segment* (defined as trades with par value above $100,000). The sample includes bond-day observations from February 24 to March 20, 2020. The dependent variables are *Log Sum Par*, the natural logarithm of daily par amount traded, and *No. of Trades*, the count of large trades per bond per day. Key variables of interest include dummies for fund holding status—*Only by ETF*, *Only by MF*, and *Both*—and their interactions with a *Crisis* dummy equal to one from March 9 to March 20, 2020. The goal is to assess whether large trades increased more for ETF-held bonds during turmoil, which would indicate active arbitrage through the ETF creation/redemption mechanism. Robust standard errors are clustered by bond and date. Variable definitions and data sources are detailed in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Log Sum Par (1)	No. of Trades (2)	Log Sum Par (3)	No. of Trades (4)	Log Sum Par (5)	No. of Trades (6)	Log Sum Par (7)	No. of Trades (8)
Only ETF	-0.148***	-0.0356	-0.140***	-0.0570*				
	(-3.69)	(-1.20)	(-2.93)	(-1.73)				
Crisis*Only ETF	0.00106	-0.00815	0.0188	0.00347				
	-0.02	(-0.27)	-0.43	-0.1				
Only MF	0.283***	0.146***			0.297***	0.177***		
	-6.67	-5.57			(7.14)	-6.64		
Crisis*Only MF	0.379***	0.165***			0.371***	0.160***		
	-6.57	-3.7			-6.44	-3.61		
Both	-0.117**	-0.0818**					-0.0533	-0.0334
	(-2.31)	(-2.15)					(-0.99)	(-0.81)
Crisis*Both	0.413***	0.216***					0.405***	0.202***
	-7.74	-4.1					-7.42	-3.83
Issue size	0.266***	0.138***	0.275***	0.0732***	0.280***	0.122***	0.255***	0.110***
	-15.44	-7.78	-14.73	-6.58	-14.12	-6.7	-13.49	-6.74
Maturity	0.137***	0.0396*	0.0222	-0.0358***	0.107***	0.021	0.114***	0.0222
	-4.45	-2.06	-1.02	(-4.82)	-3.81	-1.4	-3.51	-1.03
Age	-0.155***	-0.0321***	-0.0980***	-0.00316	-0.0915***	-0.00843	-0.161***	-0.0375**
	(-7.80)	(-2.98)	(-4.54)	(-0.53)	(-4.59)	(-0.79)	(-7.51)	(-2.56)
Coupon	-0.0415**	0.00739	0.00308	0.0383**	-0.0403**	0.0154	-0.016	0.0152
	(-2.26)	-0.43	-0.15	-2.37	(-2.14)	-0.96	(-0.81)	-0.76
Is guaranteed	0.432***	0.154***	0.260***	0.0715**	0.291***	0.0751*	0.406***	0.137**
	-8.36	-3.57	-4.29	-2.29	-4.68	-1.9	-5.88	-2.48
Insured	-0.183**	0.142**	0.0379	0.00409	-0.208**	0.144**	-0.116	0.0456
	(-2.42)	-2.41	-0.67	-0.09	(-2.72)	-2.25	(-1.31)	-1.12
Bank qualified	0.471***	0.137***	0.460***	0.120**	0.477***	0.122**	0.491***	0.166***
	-5.44	-2.9	-6.02	-2.6	-5.38	-2.36	-6.05	-3.19
AMT	1.036***	-0.111*	1.063***	-0.207**	1.060***	-0.105	1.114***	-0.135
	-14.38	(-1.91)	-7.77	(-2.42)	-13.65	(-1.65)	-9.58	(-1.72)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	8.826***	-0.921**	8.655***	0.107	8.641***	-0.662*	8.896***	-0.467
	-23.84	(-2.58)	-23.98	-0.53	-21.33	(-1.93)	-23.15	(-1.39)
No. of observations	56315	56315	25384	25384	40294	40294	34746	34746
Adjusted R^2	0.344	0.164	0.371	0.078	0.391	0.168	0.327	0.138

Table 5: Trading Volume During the COVID Crisis (Small-Trade-Size Segment)

This table reports results from a difference-in-differences regression estimating the impact of COVID-19 turmoil on bond trading volume, focusing specifically on *small-trade-size segment* (defined as trades with par value below $100,000). The sample includes bond-day observations from February 24 to March 20, 2020. The dependent variables are *Log Sum Par*, the natural logarithm of daily par amount traded, and *No. of Trades*, the count of small trades per bond per day. Key variables of interest include dummies for fund holding status—*Only by ETF*, *Only by MF*, and *Both*—and their interactions with a *Crisis* dummy equal to one from March 9 to March 20, 2020. The goal is to assess whether small trades increased more for ETF-held bonds during turmoil, which would indicate active arbitrage through the ETF creation/redemption mechanism. Robust standard errors are clustered by bond and date. Variable definitions and data sources are detailed in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Log Sum Par (1)	No. of Trades (2)	Log Sum Par (3)	No. of Trades (4)	Log Sum Par (5)	No. of Trades (6)	Log Sum Par (7)	No. of Trades (8)
Only ETF	-0.0546***	-0.0489***	-0.0567***	-0.0238**				
	(-3.26)	(-2.99)	(-3.21)	(-2.16)				
Crisis*Only ETF	0.0971***	0.0613***	0.0995***	0.0537***				
	(4.76)	(3.41)	(4.84)	(3.26)				
Only MF	-0.00391	-0.0713**			0.0104	-0.0207		
	(-0.26)	(-2.61)			(0.70)	(-0.96)		
Crisis*Only MF	0.0423***	0.104**			0.0434***	0.0984**		
	(3.15)	(2.56)			(3.20)	(2.44)		
Both	-0.0419*	-0.0651					-0.0376	-0.0746*
	(-2.00)	(-1.70)					(-1.70)	(-1.78)
Crisis*Both	0.133***	0.216***					0.134***	0.217***
	(6.18)	(3.68)					(5.98)	(3.64)
Issue size	0.106***	0.114***	0.0779***	0.0540***	0.0933***	0.0740***	0.0997***	0.104***
	(15.88)	(6.87)	(10.74)	(10.62)	(13.50)	(7.26)	(13.85)	(6.34)
Maturity	-0.0709***	0.0316***	-0.101***	0.0153***	-0.0847***	0.0319***	-0.0848***	0.0242**
	(-10.37)	(4.07)	(-10.37)	(3.03)	(-9.52)	(4.42)	(-10.02)	(2.77)
Age	-0.0678***	-0.0598***	-0.0724***	-0.00825	-0.0688***	-0.0268***	-0.0734***	-0.0553***
	(-10.41)	(-4.51)	(-10.36)	(-1.42)	(-9.92)	(-3.97)	(-10.57)	(-3.66)
Coupon	-0.00596	-0.0152***	0.00944	-0.00738*	-0.0044	-0.0148***	0.00574	-0.0134**
	(-0.87)	(-2.89)	(1.46)	(-1.89)	(-0.62)	(-4.11)	(0.91)	(-2.18)
Is guaranteed	0.193***	-0.0422	0.0757***	0.00629	0.167***	-0.0719**	0.119***	0.0202
	(9.93)	(-1.31)	(2.99)	(0.22)	(8.00)	(-2.29)	(5.26)	(0.65)
Insured	0.0417***	0.120***	0.0476**	0.0860***	0.0434**	0.104***	0.0529***	0.0999***
	(2.95)	(6.42)	(2.56)	(4.96)	(2.63)	(5.23)	(3.33)	(3.86)
Bank qualified	0.166***	0.0935***	0.159***	0.0645***	0.158***	0.0637***	0.177***	0.101***
	(7.99)	(5.02)	(7.13)	(3.67)	(7.36)	(3.66)	(8.01)	(5.91)
AMT	-0.237***	-0.00208	-0.233***	0.0365	-0.198***	0.0634	-0.249***	-0.0114
	(-7.53)	(-0.06)	(-6.02)	(0.73)	(-5.61)	(1.64)	(-6.41)	(-0.23)
Constant	8.867***	-0.328	9.299***	0.494***	9.082***	0.231	8.952***	-0.187
	(72.59)	(-1.39)	(73.45)	(5.88)	(73.75)	(1.50)	(70.64)	(-0.82)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	220848	220848	145125	145125	171062	171062	165504	165504
Adjusted R^2	0.096	0.053	0.092	0.021	0.105	0.077	0.097	0.021

Table 6: Trading Volume Changes Induced by Fund Outflows

This table reports regression results examining the effect of fund outflows on municipal bond trading volume during the COVID-19 crisis (March 9–20, 2020). The dependent variable is *Log Sum Par*, the natural logarithm of the bond's daily par amount traded. $Fund\ Flow_{i,t}$ is computed as:

$$\text{Fund Flow}_{i,t} = \frac{\sum_k (\text{Holding Amount}_{i,k} \times \text{Outflow}_{k,t-1,t})}{\sum_k \text{Holding Amount}_{i,k}},$$

where $Outflow_{k,t-1,t}$ is the net percentage outflow of ETF k from $t-1$ to t, adjusted for fund returns. This variable captures exposure-weighted ETF selling pressure for bond i. Columns (1)–(2) present results for the full sample of municipal bonds. Columns (3)–(4) restrict the sample to bonds held exclusively by mutual funds; Columns (5)–(6) to bonds held only by ETFs; and Columns (7)–(8) to bonds held by both fund types. Control variables include bond characteristics (issue size, maturity, age, coupon), structural features (insurance status, bank-qualified designation, AMT flag), and fixed effects for date, credit rating, bond type, embedded options, and state. Columns (2), (4), (6), and (8) include *Total Share*, the percentage of the bond's outstanding value held by funds. Standard errors are clustered at the bond and date levels. Variable definitions and data sources are detailed in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Trading Volume (Log Sum Par)							
	All		Only MF		Only ETF		Both	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fund Flow	3.290**	4.318**	5.839*	5.805*	1.139	1.213	3.985**	4.294*
	(2.43)	(2.86)	(2.03)	(2.21)	(0.73)	(0.84)	(2.35)	(1.94)
Issue size	0.369***	0.368***	0.336***	0.372***	0.268***	0.265***	0.507***	0.503***
	(15.84)	(16.18)	(11.51)	(12.63)	(9.42)	(9.31)	(12.65)	(12.50)
Maturity	0.152***	0.0941***	0.150**	0.0889	-0.0144	-0.0128	0.136***	0.100***
	(5.34)	(3.61)	(2.95)	(1.83)	(-0.38)	(-0.33)	(4.60)	(3.49)
Age	-0.300***	-0.229***	-0.240***	-0.189***	-0.195***	-0.178***	-0.411***	-0.348***
	(-10.14)	(-8.69)	(-6.27)	(-5.44)	(-4.69)	(-4.06)	(-9.02)	(-7.87)
Coupon	-0.0404	-0.0462	-0.0488	-0.0488	0.0862**	0.0855**	-0.00987	-0.0156
	(-1.58)	(-1.78)	(-1.51)	(-1.55)	(2.42)	(2.40)	(-0.37)	(-0.57)
Is guaranteed	1.285***	1.319***	1.043***	1.083***	0.438**	0.450**	1.686***	1.721***
	(14.32)	(15.28)	(9.67)	(10.72)	(3.03)	(3.15)	(7.07)	(7.56)
Insured	-0.0746	-0.0834	-0.0489	-0.0837	0.205	0.205	-0.211	-0.162
	(-0.94)	(-1.18)	(-0.50)	(-0.98)	(1.51)	(1.49)	(-1.52)	(-1.16)
Bank qualified	-0.0573	-0.133	0.0182	-0.0537	0	0	0	0
	(-0.13)	(-0.34)	(0.03)	(-0.10)	(.)	(.)	(.)	(.)
AMT	0.469***	0.403***	0.419***	0.361**	-0.555	-0.561	1.653***	1.559***
	(4.31)	(3.73)	(3.67)	(3.13)	(-1.44)	(-1.48)	(4.77)	(4.64)
Total Share		1.102***		1.219***		0.604*		0.763***
		(17.03)		(15.61)		(2.26)		(9.21)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	5.362***	5.078***	6.173***	5.159***	6.290***	6.291***	2.774***	2.595***
	(10.65)	(10.16)	(10.16)	(8.29)	(16.18)	(16.27)	(3.64)	(3.36)
No. of observations	63342	63342	29537	29537	9630	9630	23631	23631
Adjusted R^2	0.337	0.353	0.437	0.455	0.167	0.168	0.241	0.248

Table 7: Dealers' Role During COVID Crisis

This table presents regression results examining dealers' net trading activity during the COVID-19 crisis. The dependent variable is *Dealer Net Purchase*, defined as the daily difference between dealers' total purchases from customers and their total sales to customers for bond i. The full sample includes bond-day observations from February 24 to March 20, 2020, with the crisis window defined as March 9 to March 20. The variable *Crisis* is a dummy equal to one for observations within the crisis period. *Only by ETF*, *Only by MF*, and *Both* are indicator variables denoting whether a bond was held exclusively by ETFs, exclusively by mutual funds, or by both as of February 2020. The interaction terms (e.g., *Crisis* $\times$ *Only by ETF*) measure how dealer behavior changed during the crisis for each bond-holding category. Columns (1)–(4) reflect alternative subsamples and specifications. Control variables include bond characteristics (issue size, maturity, age, coupon), structural features (insurance status, bank-qualified designation, AMT flag), and fixed effects for date, rating, bond type, embedded options, and state. Standard errors are clustered at the bond and date level. The superscripts *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Dealer Net Purchase			
	(1)	(2)	(3)	(4)
Only ETF	0.00460*	0.00561**		
	(1.95)	(2.64)		
Only MF	(0.00)		(0.00)	
	(-0.25)		(-0.24)	
Both	0.0138*			0.0158*
	(1.85)			(2.09)
Crisis*Only ETF	-0.00853*	-0.00897*		
	(-1.68)	(-1.69)		
Crisis*Only MF	0.0218*		0.0220*	
	(1.67)		(1.67)	
Crisis*Both	-0.0324***			-0.0317***
	(-3.41)			(-3.32)
Issue size	0.00739**	0.00	0.00772**	0.00
	(2.82)	(0.65)	(2.77)	(1.46)
Maturity	-0.0102***	-0.00524*	-0.00906***	-0.00764***
	(-3.55)	(-2.05)	(-3.40)	(-3.06)
Age	0.00	0.00	(0.00)	0.00
	(0.24)	(0.40)	(-0.03)	(0.24)
Coupon	-0.0213**	(0.01)	-0.0243**	(0.01)
	(-2.60)	(-1.68)	(-2.80)	(-1.40)
Is guaranteed	0.03	0.01	0.04	0.01
	(0.79)	(0.35)	(0.82)	(0.33)
Insured	0.01	(0.01)	0.01	(0.01)
	(0.81)	(-1.05)	(1.25)	(-1.39)
Bank qualified	-0.0124**	-0.0108***	-0.0135**	-0.00947**
	(-2.26)	(-2.95)	(-2.53)	(-2.71)
AMT	(0.03)	(0.04)	-0.0401**	(0.01)
	(-1.10)	(-1.26)	(-2.19)	(-0.29)
Date fixed effects	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y
Constant	(0.01)	0.03	(0.00)	0.00
	(-0.11)	(0.87)	(-0.02)	(0.04)
No. of observations	220848.00	145125.00	171062.00	165504.00
Adjusted R^2	(0.02)	(0.02)	(0.02)	(0.04)

Table 8: Trading Costs During the COVID Crisis

This table presents the results for bond liquidy analysis as measured by trading cost, examining the interactions among bond holding status, the COVID crisis period, and different trading size. The sample comprises bond-day observations from February 24 to March 20, 2020. Trading cost is the bid-ask spared for bond_i on day_t. Crisis is a dummy variable indicating whether the trading volume observation falls within the defined COVID crisis period (March 9 to March 20, 2020). 'Only by ETF,' 'Only by MF,' and 'Both' indicate whether a municipal bond was held exclusively by ETFs, exclusively by MFs, or by both, respectively. The detailed definitions of variables and data sources can be found in Appendix A. The superscripts *, **, and *** denote significance at 0.10, 0.05, and 0.01 levels, respectively.

	Dependent variable: Trading Cost							
	Large Trade Size				Small Trade Size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Only ETF	0.0725***	0.0589*			-0.051	-0.0556		
	(3.25)	(1.73)			(-1.22)	(-1.16)		
Crisis*Only ETF	0.00	(0.01)			0.04	0.184**		
	(0.19)	(-0.39)			(0.91)	(2.65)		
Only MF	0.02		0.03		0.157**		-0.144***	
	(1.24)		(1.69)		(2.55)		(-5.81)	
Crisis*Only MF	-0.152***		-0.156***		-0.214***		0.04	
	(-6.10)		(-5.98)		(-5.70)		(0.91)	
Both	0.0915***			0.0483*	-0.157***			-0.238***
	(3.55)			(1.87)	(-7.31)			(-5.40)
Crisis*Both	-0.0858***			-0.0840***	0.298***			0.305***
	(-3.37)			(-3.45)	(4.56)			(4.57)
Issue size	-0.0507***	-0.0340**	-0.0608***	-0.0415**	0.101***	0.103***	0.0910***	0.110***
	(-5.00)	(-2.28)	(-6.12)	(-2.81)	(8.57)	(7.96)	(9.64)	(8.66)
Maturity	0.111***	0.158***	0.0874***	0.140***	0.332***	0.352***	0.332***	0.340***
	(12.17)	(9.37)	(6.44)	(7.80)	(21.16)	(22.72)	(21.32)	(22.05)
Age	-0.0518***	-0.0611***	-0.0624***	-0.0610***	(0.03)	(0.02)	(0.02)	(0.02)
	(-6.09)	(-3.75)	(-4.88)	(-6.10)	(-1.32)	(-0.68)	(-0.82)	(-0.76)
Coupon	-0.0592***	-0.0861***	-0.0621***	-0.0653***	-0.0677***	-0.0809***	-0.0635***	-0.0725***
	(-5.94)	(-6.88)	(-6.96)	(-5.10)	(-6.71)	(-5.39)	(-5.92)	(-5.52)
Is guaranteed	-0.241***	-0.151***	-0.209***	-0.269***	(0.07)	0.00	(0.10)	(0.03)
	(-8.16)	(-2.89)	(-7.38)	(-5.16)	(-0.96)	(0.05)	(-1.04)	(-0.43)
Insured	0.0700*	0.237**	0.03	0.16	0.0709*	0.02	0.06	0.02
	(1.86)	(2.47)	(0.65)	(1.63)	(1.77)	(0.33)	(1.68)	(0.42)
Bank qualified	0.11	0.187*	0.09	0.212**	0.04	0.08	0.04	0.101*
	(1.62)	(1.88)	(1.51)	(2.49)	(0.71)	(1.28)	(0.56)	(1.76)
AMT	-0.201***	0.01	-0.177***	(0.07)	0.284**	0.08	0.223**	0.25
	(-5.04)	(0.09)	(-4.51)	(-0.70)	(2.81)	(0.57)	(2.43)	(1.61)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	1.406***	1.187***	1.615***	1.284***	-0.860***	-0.885***	-0.729***	-0.994***
	(7.82)	(5.03)	(10.04)	(5.00)	(-5.13)	(-5.31)	(-5.09)	(-5.81)
No. of observations	16019.00	4804.00	10675.00	8231.00	42665.00	25213.00	30222.00	30565.00
Adjusted R^2	0.31	0.33	0.39	0.26	0.20	0.22	0.20	0.21

Table 9: Post-Crisis Recovery Analysis

This table presents regression results examining market recovery around two key Federal Reserve interventions—March 23 and April 9, 2020. The analysis compares trading volume and trading costs in the two-week windows before and after each intervention, using bond-day observations spanning February 24 to April 23, 2020. Columns (1)–(3) assess the short-term impact following the March 23 announcement of expanded liquidity facilities; Columns (4)–(6) evaluate the effects after the April 9 introduction of the Municipal Liquidity Facility (MLF), which directly targeted the muni market. The dependent variables are: *Log Sum Par* (natural logarithm of daily par value traded), *No. of Trades* (daily trade count), and *Trading Cost* (bid-ask spread). The main explanatory variables are interactions between each bond's holding status and a *Post Crisis* indicator, equal to one for the two-week window following each intervention. 'Only by ETF,' 'Only by MF,' and 'Both' classify bonds based on fund ownership as of February 2020. Control variables include bond characteristics (issue size, maturity, age, coupon), structural features (insurance, bank-qualified status, AMT flag), and fixed effects for date, rating, bond type, embedded options, and state. The results show limited evidence of market improvement after the March 23 announcement, but significant recovery—especially in trading costs—following the April 9 intervention. Standard errors are clustered at the bond and date levels. Variable definitions and data sources are detailed in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Recovery after March 23			Recovery after April 9		
	Log Sum Par	No. of Trades	Trading Cost	Log Sum Par	No. of Trades	Trading Cost
	(1)	(2)	(3)	(4)	(5)	(6)
Only ETF	-0.00811	-0.0412**	0.0989**	0.00145	-0.021	0.123***
	(-0.35)	(-2.68)	(2.46)	(0.06)	(-1.42)	(3.30)
Only MF	0.392***	0.120**	-0.218***	0.437***	0.141***	-0.254***
	(13.41)	(2.81)	(-6.53)	(14.97)	(3.69)	(-7.78)
Both	0.253***	0.131**	0.0105	0.313***	0.187***	0.00286
	(7.42)	(2.25)	(0.28)	(9.49)	(3.62)	(0.08)
Post Crisis*Only ETF	-0.0394	0.0351	0.0203	-0.0989***	-0.0758***	-0.182***
	(-1.20)	(1.18)	(0.36)	(-3.32)	(-3.97)	(-3.65)
Post Crisis*Only MF	-0.156***	-0.0952	0.0513	-0.263***	-0.186***	0.131***
	(-3.40)	(-1.46)	(0.94)	(-7.60)	(-3.24)	(3.01)
Post Crisis*Both	-0.0452	-0.0207	-0.0653	-0.222***	-0.243***	-0.0862*
	(-0.91)	(-0.21)	(-1.06)	(-4.94)	(-2.89)	(-1.79)
Issue size	0.280***	0.201***	0.0139	0.250***	0.176***	0.0216**
	(25.97)	(10.69)	(1.58)	(16.92)	(8.93)	(2.48)
Maturity	-0.000227	0.0615***	0.200***	-0.0215	0.0603***	0.260***
	(-0.02)	(5.90)	(10.00)	(-1.52)	(6.03)	(11.54)
Age	-0.183***	-0.0761***	-0.0182	-0.186***	-0.0547***	0.00598
	(-16.17)	(-5.52)	(-1.16)	(-13.69)	(-3.50)	(0.49)
Coupon	0.0103	-0.00468	-0.0577***	-0.000852	0.00855	-0.0517***
	(0.65)	(-0.52)	(-5.53)	(-0.04)	(0.85)	(-4.30)
Is guaranteed	0.808***	0.0907**	-0.406***	0.789***	0.0824**	-0.421***
	(16.75)	(2.65)	(-11.02)	(13.80)	(2.54)	(-12.05)
Insured	-0.0394	0.207***	0.00985	-0.0479	0.179***	0.024
	(-1.51)	(5.50)	(0.27)	(-1.44)	(5.28)	(0.68)
Bank qualified	0.433***	0.198***	-0.121***	0.467***	0.191***	-0.0165
	(13.37)	(9.33)	(-3.45)	(13.31)	(9.43)	(-0.49)
AMT	0.441***	-0.094	-0.0787	0.363***	-0.0942**	-0.037
	(7.26)	(-1.64)	(-0.85)	(5.37)	(-2.26)	(-0.51)
Date fixed effects	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y
Constant	6.505***	-1.666***	0.900***	7.088***	-1.370***	0.451***
	(28.76)	(-5.36)	(5.40)	(23.31)	(-4.30)	(2.97)
No. of observations	330646	330646	90578	262067	262067	69571
Adjusted R^2	0.307	0.06	0.124	0.29	0.053	0.166

Internet Appendix for
Stress-Tested: Municipal Bond ETFs During Market Turmoil

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July 25, 2025

Table IA1: Trading Volume During the COVID Crisis: A Balanced Sample Analysis

This table presents the results using a balanced sample of all municipal bonds outstanding during the COVID crisis period, including bonds that did not trade. Bonds with zero trading activity are assigned a trading volume of zero. The dependent variables are *Log Sum Par*, the natural logarithm of a bond's total daily par value traded, and *No. of Trades*, the number of trades per bond-day. The key independent variables capture fund ownership status (*Only ETF*, *Only MF*, and *Both*) and their interactions with the *Crisis* dummy, which equals one for observations from March 9 to March 20, 2020. This robustness check ensures that baseline results are not driven by selection bias.

	Log Sum Par (1)	No. of Trades (2)
Only ETF	0.162***	0.0135**
	(5.24)	(2.31)
Only MF	-0.0909***	-0.0157***
	(-6.23)	(-4.65)
Both	0.285***	0.0354***
	(8.41)	(4.24)
Crisis*Only ETF	0.217***	0.0400***
	(3.41)	(3.63)
Crisis*Only MF	0.0809***	0.0212***
	(3.89)	(3.80)
Crisis*Both	0.274***	0.0843***
	(3.60)	(3.60)
Issue size	0.176***	0.0274***
	(29.37)	(15.66)
Maturity	0.0256***	0.00417***
	(14.61)	(11.20)
Age	0.0337***	0.00425***
	(15.68)	(13.06)
Coupon	(0.01)	(0.00)
	(-0.74)	(-0.60)
Is guaranteed	0.199***	0.0306***
	(11.27)	(8.66)
Insured	0.0176**	0.00682***
	(2.65)	(4.78)
Bank qualified	0.0361***	0.00745***
	(8.61)	(6.25)
AMT	-0.197***	-0.0334***
	(-10.64)	(-10.17)
Date fixed effects	Y	Y
Rating fixed effects	Y	Y
Type fixed effects	Y	Y
Option fixed effects	Y	Y
State fixed effects	Y	Y
Constant	-2.312***	-0.367***
	(-17.57)	(-11.04)
No. of observations	10408680	10408680
Adjusted R^2	0.063	0.047

Table IA2: Alternative COVID Crisis Period (Three Weeks)

This table presents results from an alternative specification using a longer crisis period to test the sensitivity of the findings. Following Haddad et al. (2021), the crisis window is defined as March 2 to March 20, 2020, and the full sample includes bond-day observations from February 10 to March 20, 2020. The dependent variables are *Log Sum Par* and *No. of Trades*, capturing trading volume. Fund holding indicators (*Only ETF*, *Only MF*, and *Both*) are interacted with the extended *Crisis* dummy. *Log Sum Par* represents the natural log of the sum of daily par value traded; *No. of Trades* is the daily trade count. The findings remain consistent, confirming that the increase in trading activity for ETF- and MF-held bonds is robust to alternative crisis date definitions. Variable definitions and sources appear in Appendix A. The superscripts *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

	Log Sum Par (1)	No. of Trades (2)	Log Sum Par (3)	No. of Trades (4)	Log Sum Par (5)	No. of Trades (6)	Log Sum Par (7)	No. of Trades (8)
Only ETF	-0.0534**	-0.0385**	-0.0488*	-0.0246*				
	(-2.05)	(-2.60)	(-1.91)	(-1.93)				
Crisis*Only ETF	0.05	0.0474***	0.0542*	0.0511***				
	(1.56)	(3.15)	(1.84)	(3.35)				
Only MF	0.109***	(0.02)			0.141***	0.01		
	(4.32)	(-1.04)			(5.95)	(0.90)		
Crisis*Only MF	0.273***	0.101***			0.271***	0.101***		
	(6.13)	(3.80)			(6.12)	(3.82)		
Both	(0.01)	-0.0579**					0.02	(0.04)
	(-0.34)	(-2.35)					(0.44)	(-1.47)
Crisis*Both	0.294***	0.187***					0.292***	0.185***
	(5.39)	(4.76)					(5.20)	(4.66)
Issue size	0.234***	0.107***	0.179***	0.0626***	0.210***	0.0779***	0.218***	0.0943***
	(18.49)	(12.57)	(19.35)	(11.99)	(18.67)	(12.38)	(18.48)	(11.00)
Maturity	-0.0519***	0.0252***	-0.118***	0.00968**	-0.0811***	0.0269***	-0.0837***	0.0173***
	(-4.13)	(4.53)	(-13.62)	(2.31)	(-6.14)	(5.69)	(-8.00)	(3.14)
Age	-0.193***	-0.0320***	-0.147***	-0.0114***	-0.158***	-0.0207***	-0.192***	-0.0277***
	(-18.18)	(-5.85)	(-18.40)	(-3.14)	(-15.38)	(-4.24)	(-19.34)	(-4.91)
Coupon	-0.0497**	(0.00)	0.01	0.00	-0.0449**	(0.00)	(0.01)	(0.00)
	(-2.50)	(-0.44)	(0.42)	(0.16)	(-2.08)	(-0.30)	(-0.75)	(-0.18)
Is guaranteed	0.874***	0.123***	0.455***	0.02	0.815***	0.0949***	0.604***	0.0577**
	(18.20)	(5.35)	(10.24)	(1.33)	(16.79)	(4.55)	(11.61)	(2.69)
Insured	-0.0812***	0.108***	(0.00)	0.0729***	-0.0742**	0.0972***	(0.02)	0.0965***
	(-3.03)	(6.98)	(-0.10)	(5.43)	(-2.58)	(6.10)	(-0.64)	(6.73)
Bank qualified	0.597***	0.0978***	0.579***	0.0725***	0.573***	0.0770***	0.609***	0.0965***
	(17.01)	(7.12)	(15.48)	(6.02)	(16.53)	(5.93)	(16.75)	(7.48)
AMT	0.391***	-0.0726***	0.342***	-0.0634*	0.418***	-0.0466*	0.454***	-0.0639**
	(6.33)	(-3.29)	(4.09)	(-1.93)	(6.65)	(-1.96)	(5.36)	(-2.23)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	7.559***	-0.309*	8.221***	0.349***	7.921***	0.114	7.685***	-0.112
	(26.65)	(-1.85)	(43.89)	(3.41)	(30.19)	(0.82)	(32.37)	(-0.73)
No. of observations	362165	362165	228886	228886	279958	279958	264716	264716
Adjusted R^2	0.317	0.118	0.261	0.049	0.36	0.104	0.263	0.109

Table IA3: Trading Volume During the COVID Crisis: Including Fund Holding Shares

This table examines whether the main findings hold when replacing fund holding dummies with continuous ownership shares. The sample includes bond-day observations from February 24 to March 20, 2020. The dependent variables are *Log Sum Par* and *No. of Trades*, reported across all trades, as well as separately for the small-trade-size segment (trades with par value below $100,000) and the large-trade-size segment (trades with par value equal to or above $100,000). *ETF Share*, *MF Share*, and *Both Share* represent the percentage of a bond's outstanding amount held by ETFs, mutual funds, or both. These variables and their interactions with the *Crisis* dummy are used to capture how ownership intensity affects trading activity during the COVID turmoil. Definitions and sources are provided in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	All		Small Trade Size		Large Trade Size	
	Log Sum Par (1)	No. of Trades (2)	Log Sum Par (3)	No. of Trades (4)	Log Sum Par (5)	No. of Trades (6)
MF Share	0.548***	-0.0457*	0.01	-0.107***	0.871***	0.234***
	(9.37)	(-1.90)	(0.44)	(-7.22)	(9.64)	(4.78)
ETF Share	0.36	-0.690***	-0.632***	-0.600***	0.07	(0.43)
	(0.89)	(-5.16)	(-3.01)	(-5.32)	(0.12)	(-1.65)
Both Share	0.293***	-0.144***	-0.0698*	-0.0994***	0.259**	-0.138**
	(4.22)	(-3.52)	(-2.02)	(-3.44)	(2.59)	(-2.51)
Crisis*MF Share	0.760***	0.266***	0.05	0.0932**	0.678***	0.266***
	(7.78)	(4.43)	(1.68)	(2.37)	(6.04)	(3.72)
Crisis*ETF Share	0.87	0.43	1.156**	0.476*	0.05	(0.31)
	(1.25)	(1.60)	(2.82)	(1.92)	(0.07)	(-0.78)
Crisis*Both Share	0.816***	0.384***	0.194***	0.200***	0.896***	0.410***
	(7.90)	(4.01)	(3.92)	(3.22)	(8.00)	(4.10)
Issue size	0.244***	0.129***	0.109***	0.0889***	0.253***	0.144***
	(18.77)	(12.53)	(17.17)	(15.53)	(14.72)	(8.33)
Maturity	-0.0559***	0.0202***	-0.0717***	0.0106**	0.117***	0.0376*
	(-3.80)	(2.95)	(-10.75)	(2.35)	(4.06)	(2.02)
Age	-0.178***	-0.0320***	-0.0674***	-0.0259***	-0.113***	-0.0246**
	(-14.82)	(-4.60)	(-10.40)	(-4.93)	(-5.49)	(-2.20)
Coupon	-0.0428*	0.00	(0.01)	-0.00744***	-0.0403*	0.01
	(-1.96)	(0.10)	(-0.83)	(-3.04)	(-2.06)	(0.48)
Is guaranteed	0.907***	0.139***	0.192***	-0.0555***	0.525***	0.184***
	(18.31)	(5.47)	(9.99)	(-3.08)	(10.79)	(4.16)
Insured	-0.0725**	0.129***	0.0420***	0.115***	-0.169**	0.147**
	(-2.36)	(6.68)	(3.00)	(8.60)	(-2.31)	(2.49)
Bank qualified	0.536***	0.112***	0.168***	0.0748***	0.429***	0.129**
	(13.46)	(7.10)	(8.17)	(5.55)	(5.21)	(2.75)
AMT	0.423***	-0.101***	-0.240***	0.01	0.982***	-0.128**
	(6.63)	(-3.54)	(-7.67)	(0.43)	(13.03)	(-2.20)
Date fixed effects	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y
Constant	7.363***	-0.640***	8.822***	0.00	8.960***	-1.001**
	(23.99)	(-3.21)	(73.50)	(0.04)	(23.57)	(-2.85)
No. of observations	268843.00	268843.00	220848.00	220848.00	56315.00	56315.00
Adjusted R^2	0.33	0.12	0.10	0.07	0.36	0.16

Table IA4: Trading Cost During the COVID Crisis: Including Fund Holding Shares

This table tests the robustness of the trading cost results by replacing fund holding dummies with continuous fund holding shares. The sample includes bond-day observations from February 24 to March 20, 2020. The dependent variable is *Trading Cost*, measured by the bid-ask spread, reported separately for large and small trades. *ETF Share*, *MF Share*, and *Both Share* represent the percentage of a bond's par amount held by ETFs, mutual funds, or both. Their interactions with the *Crisis* dummy capture whether ownership intensity influenced liquidity during the COVID crisis. Full variable definitions are in Appendix A. Superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: Trading Cost							
	Large Trade Size				Small Trade Size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Crisis	0.281***	0.324***	0.252***	0.327***	0.674***	0.652***	0.636***	0.672***
	(4.87)	(4.99)	(5.19)	(5.08)	(5.78)	(5.82)	(6.07)	(5.67)
MF Share	(0.01)		0.02		-0.350***		-0.334***	
	(-0.57)		(0.91)		(-6.19)		(-5.15)	
ETF Share	0.28	0.56			-1.304**	-1.388*		
	(0.59)	(1.05)			(-2.33)	(-2.04)		
Both Share	0.00			(0.04)	-0.464***			-0.504***
	(0.09)			(-0.78)	(-5.93)			(-5.23)
Crisis*MF Share	-0.233***		-0.194***		0.11		0.17	
	(-6.38)		(-5.74)		(0.89)		(1.17)	
Crisis*ETF Share	(0.40)	-1.064*			2.559***	2.831***		
	(-0.71)	(-1.67)			(3.14)	(3.07)		
Crisis*Both Share	-0.130**			-0.213***	0.658***			0.677***
	(-2.73)			(-3.86)	(5.52)			(5.59)
Issue size	-0.0401***	(0.02)	-0.0640***	-0.0250*	0.0918***	0.105***	0.0794***	0.102***
	(-4.26)	(-1.23)	(-6.29)	(-1.97)	(6.72)	(6.86)	(7.06)	(7.45)
Maturity	0.127***	0.160***	0.104***	0.163***	0.337***	0.352***	0.338***	0.345***
	(13.60)	(8.34)	(6.62)	(11.57)	(18.82)	(19.62)	(19.47)	(19.26)
Age	-0.0586***	-0.0678***	-0.0655***	-0.0748***	(0.03)	(0.02)	(0.02)	(0.02)
	(-5.87)	(-4.11)	(-4.36)	(-8.51)	(-1.55)	(-0.65)	(-0.82)	(-0.96)
Coupon	(0.01)	-0.0338***	-0.0156*	-0.0246**	-0.0438***	-0.0567**	-0.0410**	-0.0489***
	(-1.52)	(-3.32)	(-1.78)	(-2.26)	(-3.32)	(-2.66)	(-2.79)	(-3.48)
Is guaranteed	-0.230***	-0.133**	-0.184***	-0.244***	(0.07)	0.01	(0.09)	(0.02)
	(-6.46)	(-2.81)	(-5.85)	(-5.15)	(-0.90)	(0.09)	(-0.98)	(-0.38)
Insured	0.0852**	0.284**	0.07	0.17	0.06	0.02	0.05	0.01
	(2.23)	(2.82)	(1.45)	(1.65)	(1.43)	(0.23)	(1.25)	(0.10)
Bank qualified	0.13	0.302**	0.11	0.303***	0.03	0.08	0.02	0.08
	(1.59)	(2.46)	(1.46)	(2.94)	(0.49)	(1.14)	(0.34)	(1.31)
AMT	-0.215***	(0.03)	-0.183***	(0.09)	0.362***	0.12	0.301**	0.300*
	(-5.31)	(-0.28)	(-4.57)	(-0.97)	(3.15)	(0.74)	(2.78)	(1.87)
Date fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Rating fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Type fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Option fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
State fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Constant	0.839***	0.518*	1.264***	0.601**	-1.244***	-1.428***	-1.064***	-1.399***
	(5.08)	(2.03)	(7.08)	(2.84)	(-6.74)	(-7.49)	(-6.82)	(-7.36)
No. of observations	16019.00	4804.00	10675.00	8231.00	42665.00	25213.00	30222.00	30565.00
Adjusted R^2	0.26	0.26	0.35	0.21	0.15	0.17	0.15	0.16