

Stress-Tested: Municipal Bond ETFs During Market Turmoil

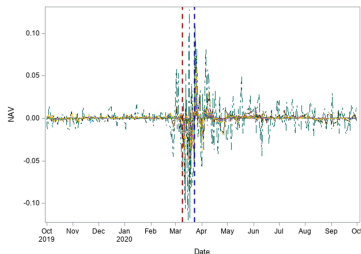
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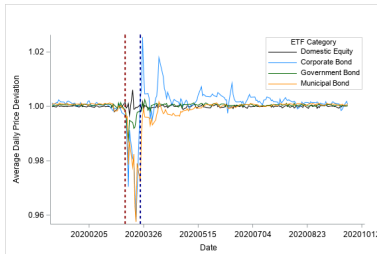
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A Liquidity Mismatch at the Center of the ETF Structure

- ▶ **Muni ETFs:** intraday liquidity, transparent pricing, \$122bn AUM by 2023
- ▶ **Underlying bonds:** fragmented OTC, thin depth, weak intermediation
- ⇒ **A liquid vehicle built on illiquid assets** – stress-tested in March 2020



Panel A: Return Volatility



Panel B: Price Deviations

**ETF returns turned volatile and prices diverged sharply and persistently from NAV:
was muni ETF liquidity still credible under stress?**

Research Question & Preview of Results

- ✓ Why did muni ETFs trade at **large and persistent discounts to NAV** through the COVID turmoil? Did APs arbitrage them?
- ✓ Did selling pressure reach the underlying bonds?

When the underlying assets are illiquid, does the ETF structure absorb stress or transmit it?

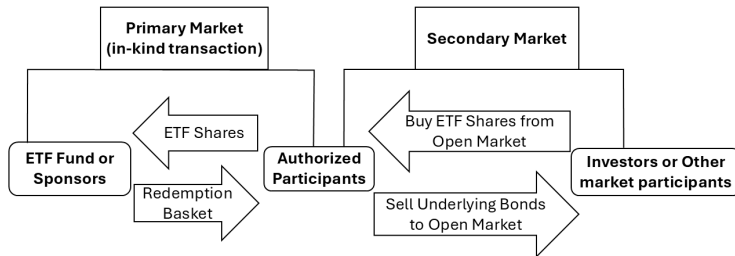
- Arbitrage was limited when it was needed most
- ETF-held bond trading rose – but in **small** trades, not institutional blocks
- Dealers pulled back; **much of** the selling pressure stayed in the **ETF layer**
- Direct muni backstop – the April 9 **MLF** – restored market confidence

Literature & Contribution

- **ETF fragility under stress** – Flash Crash, Taper Tantrum (*Madhavan 2018; Ben-David et al. 2018*)
- **Fixed-income ETF arbitrage** – AP inventory management; flow pressure on the underlying (*Pan & Zeng 2017; Dannhauser & Hoseinzade 2022*)
- **Muni ETFs** – MSRB (2018, 2020) documents growth and the March 2020 episode; Marlowe (2020) documents bonds held by ETFs trade more often than bonds held by mutual funds by studying ETF-held bonds from 2010–2020

This paper: bond-level evidence on muni ETF behavior during COVID; traces the mechanism linking bond trading, dealer intermediation, and trading costs; shows selling pressure largely stayed in the ETF layer.

How ETF Arbitrage Is Supposed to Work – and Why It May Break Down in Munis



- $\text{ETF price} < \text{NAV} \rightarrow \text{APs buy ETF shares, redeem for bonds, and profit from the gap, pushing prices back toward NAV.}$
- But in munis, the underlying securities are fragmented and thinly traded; APs are not obligated to create/redeem, and may step back when stress raises inventory risk; liquidity demand concentrates in the ETF layer

Hypotheses

- ✓ **H1 – Trading activity:** ETF-held bonds saw larger increases in trading during the crisis than bonds held by no fund.
- ✓ **H2 – Dealer intermediation:** During the crisis, dealers (incl. APs) reduced liquidity provision to ETF-held bonds *relative to comparable bonds*, limiting arbitrage capacity.
- ✓ **H3 – Trading costs:** During the crisis, trading costs for ETF-held bonds rose *relative to comparable bonds*, raising the effective cost of arbitrage.
- ✓ **H4 – Policy:** The April 9 MLF had a stronger impact on recovery in trading activity and liquidity for ETF-held bonds than the earlier MMLF.

Data, Sample & Bond Classification

- ✓ **Data:** CRSP (fund holdings) · MSRB RTRS (muni transactions) · Refinitiv Eikon (bond characteristics)
- ✓ **Sample:** bonds outstanding Oct 2019–Sep 2020, traded at least once; bond–day panel
- ✓ **Crisis window:** March 9–20, 2020
- ✓ **Ownership groups** (Feb 2020 holdings, immediately pre-turmoil): *Only ETF* · *Only MF* · *Both* · *None*

Robustness: balanced panel including zero-trading bonds.

Descriptive Statistics: Municipal Bond ETFs

	Mean	Median	Std. Dev.	No. of ETFs
Fund Age (years)	4.88	2.43	4.57	59
Fund Avg. AUM (mn)	797.27	79.20	2234.82	59
% Invested in Muni Bonds	97.22	98.81	14.65	59
Wtd. Avg. Maturity (years)	12.16	11.90	5.81	59
Expense Ratio (%)	0.26	0.24	0.0012	59
Turnover Ratio (%)	33.79	15.00	0.4386	59

- ▶ The number of bonds held by ETFs increased from about 26,000 in 2019 to over 36,000 by 2023.
- ▶ ETFs tend to hold plainer, more standardized, and shorter-maturity bonds than mutual funds.

Empirical Design

$$\begin{aligned} \text{Trading Volume}_{i,t} = & \alpha + \beta_1 \text{Crisis}_t + \beta_{2-4} \text{Ownership}_i \\ & + \beta_{5-7} (\text{Ownership}_i \times \text{Crisis}_t) + \beta_8 \text{Controls}_{i,t} + \text{Fixed Effects} + \epsilon_{i,t} \end{aligned}$$

- **Dependent variable:** log of a bond's total daily par value traded, scaled by face value issued. Coefficients of interest are the ownership $\times$ crisis interactions.
- **Controls:** issue size, maturity, age, coupon, guarantee, insurance, bank-qualified, and AMT status.
- **Fixed effects & SEs:** date, rating, bond type, options, and issuer FE; standard errors two-way clustered by bond (CUSIP) and date.

ETF-Held Bonds Became More Active During the Crisis

Dependent Variable: Trading Volume				
	(1)	(2)	(3)	(4)
Only ETF	-0.0832*** (-2.86)	-0.0612* (-2.07)		
Crisis × Only ETF	0.0636** (1.96)	0.0670** (2.05)		
Only MF	0.144*** (5.05)		0.184*** (6.54)	
Crisis × Only MF	0.285*** (6.73)		0.285*** (6.80)	
Both	-0.0191 (-0.48)			0.0118 (0.30)
Crisis × Both	0.336*** (7.29)			0.340*** (7.19)
Controls & FE	Y	Y	Y	Y
Observations	268,843	169,125	207,570	195,660
Adjusted R ²	0.471	0.514	0.454	0.526

- ETF-held bonds traded significantly more during the crisis – supports **H1**.
- ETF-held volume rose +7%; MF-held rose +33% and both-held +40% – the MF response is $\approx 5\times$ larger.
- Large-scale arbitrage, or fragmented trading? → next slide.

FE: date, rating, type, option, issuer. SEs two-way clustered by CUSIP and date.

The Increase in ETF-Held Bond Trading Came Primarily from Small Trades

Large trades ($\geq \$100K$) $\approx$ institutional activity, incl. AP arbitrage; **small trades ($< \$100K$)** $\approx$ fragmented, retail-driven activity (84.5% of trades in ETF-only bonds are $< \$100K$). Arbitrage at scale should show up in **large** trades.

	Large Trades				Small Trades			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Only ETF	-0.155*** (-3.86)	-0.140*** (-2.95)			-0.0559*** (-3.29)	-0.0567*** (-3.19)		
Crisis $\times$ Only ETF	0.00142 (0.03)	0.0194 (0.44)			0.0971*** (4.73)	0.0991*** (4.81)		
Only MF	0.277*** (6.49)		0.294*** (7.08)		-0.0061 (-0.41)		0.0100 (0.66)	
Crisis $\times$ Only MF	0.381*** (6.57)		0.373*** (6.45)		0.0461*** (3.28)		0.0471*** (3.33)	
Both	-0.132** (-2.64)			-0.0723 (-1.36)	-0.0446* (-2.08)			-0.0407* (-1.82)
Crisis $\times$ Both	0.416*** (7.79)			0.408*** (7.46)	0.138*** (6.08)			0.139*** (5.90)
Controls & FE	Y	Y	Y	Y	Y	Y	Y	Y
N	56,315	25,384	40,294	34,746	220,848	145,125	171,062	165,504
Adj. R^2	0.445	0.545	0.395	0.540	0.733	0.682	0.696	0.753

For ETF-only bonds: **small trades** +10%, **large trades** ≈ 0 – hard to reconcile with block-level AP arbitrage. For MF-only bonds, large trades rose +45%: forced institutional selling.

FE: date, rating, type, option, issuer.

Measuring Bond-Level Fund Pressure

- Construct a bond-level measure of **fund pressure**, following Dannhauser and Hoseinzade (2022):

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

- A bond faces more pressure if it is more heavily held by funds experiencing outflows.
- I regress trading volume on Fund Pressure, controlling for total ownership share and bond characteristics, to test whether outflow pressure transmits into trading – especially for ETF-only bonds, where it should be most visible if arbitrage is active.

If ETF investor selling spills into the underlying bond market, bonds exposed to ETF outflows should trade more.

ETF Selling Pressure Did Not Materially Transmit to ETF-Only Bonds

	Dependent Variable: Trading Volume							
	All		Only ETF		Only MF		Both	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fund Pressure	1.922** (2.42)	1.907** (2.37)	0.103 (0.15)	0.174 (0.28)	2.966* (1.82)	2.834* (1.73)	1.970* (1.90)	1.921* (1.81)
Total Share		0.212*** (3.79)		0.723*** (3.11)		0.207*** (3.41)		0.143* (1.80)
Controls & FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	112,088	112,088	16,873	16,873	52,551	52,551	42,184	42,184
Adj. R^2	0.345	0.348	0.271	0.272	0.371	0.374	0.239	0.240

Fund pressure predicts higher trading volume for MF-related bonds – but **not** for ETF-only bonds. ETF selling pressure stayed in the **ETF secondary market** rather than transmitting to the underlying bonds.

FE: date, rating, type, option, issuer.

Dealers Pulled Back from ETF-Held Bonds During Crisis

Dependent Variable: Dealer Net Purchase

	(1)	(2)	(3)	(4)
Only ETF	0.0046* (1.95)	0.0056** (2.64)		
Crisis × Only ETF	−0.0085* (−1.68)	−0.0090* (−1.69)		
Only MF	−0.002 (−0.25)		−0.003 (−0.24)	
Crisis × Only MF	0.0218* (1.67)		0.0220* (1.67)	
Both	0.0138* (1.85)			0.0158* (2.09)
Crisis × Both	−0.0324*** (−3.41)			−0.0317*** (−3.32)
Controls & FE	Y	Y	Y	Y
Observations	220,848	145,125	171,062	165,504
Adj. R^2	0.02	0.02	0.02	0.04

- Dealers (incl. APs) **cut** net purchases of ETF-held bonds during the crisis. . .
- . . . but **raised** net purchases of MF-held bonds – absorbing forced redemptions, not supporting arbitrage.
- The MF-side support is $> 2\times$ the ETF-side pullback – a reallocation of scarce balance sheet.

FE: date, rating, type, option, state.

Trading Costs Increased for ETF-Held Bonds

Dependent Variable: Trading Cost (Bid-Ask Spread)

	(1)	(2)	(3)	(4)
Only ETF	-0.019 (0.037)	-0.031 (0.046)		
Crisis × Only ETF	0.131** (0.062)	0.148** (0.070)		
Only MF	-0.101*** (0.021)		-0.102*** (0.022)	
Crisis × Only MF	-0.139*** (0.041)		-0.143*** (0.042)	
Both	-0.088*** (0.029)			-0.121*** (0.030)
Crisis × Both	0.099** (0.051)			0.098* (0.052)
Controls & FE	Y	Y	Y	Y
Observations	62,261	32,532	43,974	41,642
Adj. R^2	0.236	0.314	0.288	0.256

- Trading costs **rose** significantly for ETF-held bonds during the crisis.
- ETF-held spreads widened +13–15 bps ($\approx$ \$150 per \$100K round trip); MF-held spreads *narrowed* –14 bps.
- Costly execution made arbitrage unattractive – discounts persisted in plain sight.

FE: date, rating, type, option, issuer.

Meaningful Recovery After the April 9 MLF Announcement

Market Reaction to Fed Interventions: March 23 and April 9, 2020

	Recovery after March 23		Recovery after April 9	
	Trading Volume (1)	Trading Cost (2)	Trading Volume (3)	Trading Cost (4)
Only ETF	-0.0117 (-0.51)	0.0989** (2.46)	-0.00323 (-0.14)	0.123*** (3.30)
Only MF	0.392*** (13.29)	-0.218*** (-6.53)	0.437*** (14.88)	-0.254*** (-7.78)
Both	0.249*** (7.16)	0.0105 (0.28)	0.309*** (9.23)	0.00286 (0.08)
PostCrisis × Only ETF	-0.0392 (-1.19)	0.0203 (0.36)	-0.0984*** (-3.32)	-0.182*** (-3.65)
PostCrisis × Only MF	-0.159*** (-3.43)	0.0513 (0.94)	-0.269*** (-7.73)	0.131*** (3.01)
PostCrisis × Both	-0.0472 (-0.94)	-0.0653 (-1.06)	-0.227*** (-4.99)	-0.0862* (-1.79)
Controls & FE	Y	Y	Y	Y
Observations	330,646	90,578	262,065	69,571
Adj. R^2	0.425	0.124	0.440	0.166

- **March 23 (MMLF):** no meaningful recovery for ETF-only bonds.
- **April 9 (MLF):** ETF-only spreads −18 bps, reversing the crisis widening; volume −9%.
- Lower costs and normalized trading intensity – better price alignment.

FE: date, rating, type, option, issuer.

Conclusion

- ✓ Municipal bond ETFs experienced large and persistent NAV dislocations during COVID.
- ✓ Arbitrage did not operate at scale: ETF-held bonds became more active, but mainly through small trades rather than large institutional transactions.
- ✓ Dealers pulled back and trading costs rose in ETF-held bonds, limiting the capacity needed to restore price alignment.
- ✓ Much of the selling pressure remained in ETF layers, and market functioning improved only after the April 9 Municipal Liquidity Facility.
- ✓ Results are robust to a balanced panel (incl. zero-trading bonds), an alternative crisis window (Mar 2–20), and continuous ownership shares.

Thank you!