The Fragility Tax: How Mutual Fund Ownership Links Segmented Markets*

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May 30, 2026

Abstract

Open-end funds' retail liability structure transmits equity shocks across otherwise-segmented asset classes, producing a structural cost-of-capital wedge in municipal bonds. Bonds held by municipal funds with high stock-market sensitivity trade at yield spreads 14–25 basis points wider than same-issuer comparables, equivalent to a multi-notch credit downgrade. We call this the Fragility Tax. When stocks fall, retail fund investors redeem municipal fund shares, forcing fire-sales priced ex ante. Only direct, liability-driven fund beta predicts yields, ruling out equity-correlated fundamentals. Fickle capital and fund liability structure raise aggregate borrowing costs by $2.5 billion annually, a pecuniary externality on local public finance.

JEL classification: G23, G12, G28, H74

Keywords: Open-end fund fragility, Fire sales, Fragility Tax, Market segmentation, Liquidity transformation, Fickle capital, Pecuniary externality, Municipal bonds

*We thank Adem Atmaz, Zahi Ben-David, Ramona Dagostino, David Hummels, Tyler Muir, Vasudha Nair, Emre Ozdenoren, Yu Su, and Kaushik Vasudevan for helpful comments.

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1 Introduction

The U.S. municipal bond (muni) market and the equity market are separated by nearly every dimension of market structure. Municipal bonds are tax-exempt, backed by the local taxing power of governments or specific revenue projects, and held primarily for capital preservation and income stability. They trade infrequently in an opaque over-the-counter market (Duffie, Gârleanu, and Pedersen, 2005) dominated by dealer intermediation (Harris and Piwowar, 2006; Li and Schürhoff, 2019), with yield spreads historically driven by credit risk, liquidity, and tax considerations (Ang, Bhansali, and Xing, 2010; Schwert, 2017). Equities, by contrast, are the residual claim on corporate cash flows, traded continuously on exchanges with deep institutional participation. Unlike corporate bond issuers, municipal issuers operate primarily within the muni market, limiting interconnectedness between their debt and public equity markets. The cash flows of a water utility in rural Ohio and a technology conglomerate in Silicon Valley share minimal fundamental covariance. This institutional segmentation (different investor clienteles, trading venues, regulatory frameworks, and underlying cash flows) implies that shocks to one market should have limited transmission to the other.

Empirical evidence, however, contradicts this prediction of limited cross-market transmission. Correlations between municipal bond returns and equity market returns rise in down markets.[1] When equity markets decline, some municipal bond prices fall alongside equities, even for issuers whose fiscal fundamentals are unaffected.[2] Why does the cost of borrowing for a local school district in Ohio increase when the S&P 500 falls? We show this cross-market transmission imposes real costs on local public finance, raising borrowing costs and constraining infrastructure investment. While prior work has emphasized supply-side constraints (such as dealer inventory limits or the spread of selling pressure during crises), we identify a structural demand-side friction that operates even when dealer markets are functioning normally.[3] Why do some bonds issued by the same municipality, with the same credit rating, see yields spike while others remain insulated?

[1] Over 2007–2021, the monthly return correlation between the S&P 500 and the Bloomberg Municipal Bond Index is 0.09. In months with S&P 500 returns in the bottom decile, the correlation rises to 0.40.

[2] Yuan (2005) provides a theoretical foundation. In her rational expectations framework, investors trading in multiple markets face borrowing constraints that tighten as prices fall, so a shock to one market reduces their demand in others and propagates to fundamentally unrelated assets.

[3] See Li, O'Hara, and Zhou (2024) on dealer inventory constraints during COVID-19 and Haddad, Moreira, and Muir (2021) on the viral propagation of selling pressure.

The answer lies not in the bonds themselves but in who owns them. Bonds held by mutual funds with high sensitivity to the stock market trade at yield spreads 14 to 25 basis points (bps) higher than fundamentally similar bonds held by low-sensitivity funds. This gap is equivalent to a multi-notch credit downgrade.[4] In dollar terms, a mid-sized county issuing a $200 million twenty-year general obligation bond pays roughly $3 million in additional interest over the life of the issue. That is the fiscal equivalent of one elementary school foregone per issuance cycle. We call this pricing wedge the "Fragility Tax." Unlike channels that operate through credit supply or fiscal fundamentals, the Fragility Tax stems from the ownership structure of municipal debt itself. Open-end municipal bond funds hold no equities, yet many exhibit substantial sensitivity to stock market returns. This sensitivity reflects not the funds' portfolios but their investors' behavior.[5]

When equity markets decline, retail investors liquidate across their portfolios, a "dash for cash" that reaches well beyond equities. Two forces drive this behavior. First, equity losses reduce household wealth and tighten borrowing constraints. Investors who need to raise cash (for margin calls, consumption needs, or liquidity buffers) must decide what to sell. Selling equities locks in losses, which investors are reluctant to realize (disposition effect). Selling individual bonds into the over-the-counter (OTC) market is costly and slow. The open-end muni fund, with its daily redemption at NAV, provides frictionless exit from an illiquid asset class, the path of least resistance for cross-asset liquidation. Second, during severe stress, the traditional flight to safety breaks down. Rather than rotating from equities into bonds, investors withdraw from fixed-income mutual funds whose liquidity transformation makes them most vulnerable to outflows (Ma, Xiao, and Zeng, 2022). Consistent with this portfolio channel, the Fragility Tax is stronger when holding funds belong to fund families that manage a larger share of equity funds. In these families, investors are most likely to hold both equity and muni funds, creating a direct conduit for cross-asset liquidation. Extrapolative expectations and low consumer sentiment (household pessimism) amplify both channels,

[4] The 14 bps comes from our most demanding matched-sample specification, which absorbs every observable bond characteristic and all time-varying issuer heterogeneity. The 25 bps comes from our baseline specification with issuer-by-date fixed effects. The credit spread between AAA and AA-rated municipal bonds is typically less than 10 bps, implying that the wedge is equivalent to a multi-notch effective credit downgrade.

[5] Unlike corporate bonds, municipal bonds are heavily retail. Households hold nearly 70% of outstanding debt, either directly or through funds (Bergstresser and Cohen, 2016; Board of Governors of the Federal Reserve System, 2025), making the market uniquely exposed to cross-asset liquidation by households.

pushing redemptions beyond what liquidity needs alone would warrant. A one-standard-deviation decline in consumer sentiment widens the Fragility Tax by 20 bps.

An alternative interpretation is that bonds held by high-sensitivity funds are riskier along some unobserved dimension, and the yield spread reflects efficient compensation for this risk. We test against this alternative by decomposing fund beta into two components: *direct* fund beta, the fund's sensitivity to equity returns after controlling for its muni-market exposure, and *indirect* fund beta, which captures the fund's exposure to fundamental muni-equity covariance. Direct fund beta isolates the fund's liability-driven equity sensitivity, the part attributable to investor redemption behavior. Indirect fund beta, by contrast, reflects fundamental muni-equity covariance common to all muni bonds. If the yield wedge reflected compensation for equity-correlated bond risk, both components should load symmetrically on yield spreads. We show that they do not. Only the direct component is positively associated with spreads; the indirect component is insignificant or negative in our strictest matched-sample design. A liability-side mechanism generates a wedge on the liability-driven component of fund beta; a fundamentals-side mechanism cannot. We confirm this with a shift-share counterfactual that holds each bond's fund ownership structure fixed at its thirteen-month lag and lets only the fund-level betas vary. The resulting rolling coefficient traces the observed time-series coefficient nearly exactly. The cyclical variation in the Fragility Tax reflects changes in fund fragility, not changes in which funds hold the bonds.

The open-end fund structure is what enables this cross-market transmission. Funds promise daily redemptions at NAV while holding assets (muni bonds) that trade in a highly illiquid market, creating a liquidity mismatch. The retail capital base of these funds is what Caballero and Simsek (2020) term *fickle capital*, which is stable in good times but prone to flight during stress. The fragility we document originates on the liability side of the intermediary balance sheet. The demandable contract of the open-end fund, not any constraint on its capital or leverage, generates the amplification. The daily redemption right is individually rational, since every investor values the option to exit. But its collective exercise generates forced liquidation and cross-market fragility, a contractual externality in the sense of Ozdenoren and Yuan (2017).

The Fragility Tax, however, does not require actual fire sales. It operates through anticipation. Bonds held by high-sensitivity funds face elevated liquidation risk, and market participants demand higher yields as compensation.[6] This results in a *cost-of-capital wedge*. Two bonds with identical municipal cash flows are discounted at different rates depending on who holds them, and the difference is not in the bonds themselves. A municipality bears this higher cost even if forced selling never materializes, because the structural vulnerability is priced continuously into the discount rate. We show that the wedge is not confined to crisis episodes. Our rolling estimate of the coefficient on fund beta is positive in calm periods such as 2019 and rises to approximately 35 bps during high-VIX months. Anticipated forced selling generates a pecuniary externality in the sense of Lorenzoni (2008). That is, the distortion arises not only from realized fire sales but from the capitalization of expected future fire-sale price movements into current borrowing costs.

We show that the aggregate consequences are substantial. The Fragility Tax raises annual municipal borrowing costs on new issuance by up to \$2.5 billion. That is roughly 1.5% of annual muni debt service.[7] Beyond this transfer from municipalities to investors compensated for bearing fire-sale risk, the friction reduces local public investment through quantity rationing by approximately \$4 billion annually. This is an allocative loss that falls on infrastructure financing rather than on bondholders. Because new municipal issues are typically benchmarked against secondary market yields of comparable outstanding bonds, this distortion transmits directly to borrowing costs at issuance. To the extent that higher borrowing costs are passed through to local taxpayers (through higher taxes, reduced services, or deferred maintenance), the friction distorts the provision of local public goods.

The transmission operates through the portfolio channel of contagion (Broner, Gelos, and Reinhart, 2006). Specifically, shocks to one asset class propagate to fundamentally unrelated markets through the balance sheets of common investors. In standard intermediary asset pricing theory, intermediaries transmit shocks through equity capital constraints on their balance sheets (He and Krishnamurthy, 2013; Adrian, Etula, and Muir, 2014; Haddad and Muir, 2021). The channel we identify complements these capital-side mechanisms. In our setting, the friction originates on the liability side of the intermediary balance sheet rather than the capital side, and the intermediary in question carries no leverage and faces no

[6] The pricing structure is analogous to De Long et al. (1990): rational investors demand compensation for bearing the risk that future redemption-driven liquidations will push prices away from fundamentals, even absent realized selling.

[7] Computed as 13.7 bps applied to annual muni issuance of \$230 billion at an eight-year average duration. The denominator for the share calculation is annual muni debt service of \$170 billion.

binding regulatory constraint. Our channel echoes demand-based models where specialized investors absorb shocks and link segmented markets (Greenwood and Vayanos, 2014; Koijen and Yogo, 2019; Greenwood et al., 2023), with the distinction that the linking here occurs through fund liabilities rather than portfolio rebalancing.

Other features of the data reinforce this interpretation. For example, the wedge is mitigated when funds hold larger cash buffers and amplified by flow pressure, retail share, and the fund family equity orientation of holding funds. These patterns track intermediary fragility rather than bond risk. Closed-end funds share the same retail client base as open-end funds but lack the redeemable liability structure. They exhibit less than half the pricing impact, pointing to the redeemable contract as the source of the friction.

Even granting that fire-sale risk deserves compensation, who bears the cost? Inside the fund, when shareholder A redeems, the fund manager must sell bonds to raise cash; those sales depress prices, and the losses fall on shareholder B, who did not redeem. But the costs extend beyond the fund itself. Fire-sale discounts widen yield spreads on the issuer's outstanding debt, raising the municipality's future borrowing costs. The municipality and its taxpayers are entirely outside the fund contract. They cannot prevent, hedge, or even observe the redemption decisions that raise their cost of capital, creating a pecuniary externality. Empirically, Chernenko and Sunderam (2020) document that mutual fund fire sales generate externalities for non-fund holders within the corporate bond market; we extend this to a cross-market setting where the externality crosses asset classes and falls on local governments outside the fund contract. The externality is also contractual in the sense of Ozdenoren and Yuan (2017). Individually optimal contract terms (here, the daily redemption right) produce collectively excessive risk. The quantity rationing we document in Section 6 is direct evidence that the externality binds. Counties whose outstanding bonds are held by high-beta funds issue less debt, showing that the price externality constrains real municipal decisions, not just distributes rents. What distinguishes our setting from standard models of fund runs is that the costs spill out of the financial sector entirely. Household portfolio decisions in one market determine the cost of capital for local governments in another.

Our analysis uses U.S. municipal bond transactions and mutual fund holdings from 2007 to 2021. Our main explanatory variable is not the beta of the bond itself but the fund beta, defined as the par-weighted stock market sensitivity of all open-end municipal bond mutual funds that own the bond. Using issuer-by-date fixed effects to control for time-varying issuer-level information and fundamentals, we find that a one-standard-deviation increase in fund beta is associated with a 25-bps increase in the tax-adjusted yield spread under the baseline specification and 14 bps under the most demanding matched-sample design.

To address the possibility that high-beta funds select riskier bonds or "reach for yield" (Greenwood and Hanson, 2013; Becker and Ivashina, 2015), we decompose the change in fund beta into an *active* component (ownership shifts toward higher-beta funds) and a *passive* component (fund-level beta changes among current holders). Active shifts toward high-beta funds significantly predict yield spread widening ($t = 11.07$), indicating that ownership structure itself affects pricing, not that high-beta funds are selected by risky bonds.

We conduct several tests to address endogeneity and selection concerns. In our most stringent identification test, we restrict the sample to mutual fund trades and include fund-by-month fixed effects, comparing bonds traded by the same fund in the same month. This specification fully absorbs fund-level selection preferences, yet the effect persists. We show that high-beta funds receive significantly worse execution prices than low-beta funds when trading the identical bond in the same month, leaving little room for bond-level explanations.

Quasi-experimental and instrumental variable evidence reinforces these findings. We employ a difference-in-differences analysis exploiting the Puerto Rico government debt crisis as independent quasi-experimental evidence. The collapse of Puerto Rico's credit rating was an idiosyncratic shock affecting funds with exposure to the island's triple-tax-exempt debt. We document that non-Puerto Rico bonds held by these exposed funds exhibited significantly higher yield spreads, despite maintaining stable credit ratings. Pre-trends are flat for both yield spreads ($F = 0.42$) and fund flows ($F = 0.99$). A shift-share instrumental variable analysis, which uses predetermined ownership shares from 13 months prior combined with current fund-level betas, confirms the causal interpretation. The effect survives direct controls for fund 12-month returns and bond-level flow pressure, indicating that the Fragility Tax operates independently of fund capital-supply effects on yields (Adelino et al., 2026).[8]

Beyond the secondary market, we document significant spillovers into the real economy. Among bonds issued in the same county and the same month, those associated with higher issuer-level *fund beta* have higher offering yield spreads of up to 14 bps. At the county

[8] The Fragility Tax operates through a different channel than the capital-supply effects of fund flows on muni issuance documented in Adelino et al. (2026). It is a cross-market channel through which equity-market shocks transmit to muni borrowing costs via fund liability fragility, with the opposite welfare implication.

level, we find that a one-standard-deviation increase in fund beta is associated with nearly \$34 less issuance per capita (about 4 percent of the sample standard deviation), consistent with quantity rationing. Because substitution to alternative financing sources such as bank financing is frictional and limited (Dagostino, 2025), reduced bond market access likely translates into net reductions in public investment.

This paper makes three contributions. First, we show that the ownership structure of municipal debt, not just the debt, shapes local public goods provision. While prior work has focused on fiscal institutions, tax policy, and credit ratings as drivers of municipal borrowing capacity (Poterba and Rueben, 1999), we show that the identity of the bondholder, independent of credit quality, affects the cost and quantity of municipal borrowing, with aggregate annual excess financing costs of up to \$2.5 billion and forgone issuance of \$4 billion. Welfare implications follow pecuniary-externality logic. Fire-sale price movements tighten the borrowing constraints of parties outside the fund contract, producing constrained inefficiency that a social planner with the same instruments would seek to correct.

Second, we document a new form of cross-market contagion operating through the portfolio channel: equity market shocks propagate to a fundamentally unrelated market through the liability structure of open-end funds. Yuan (2005) formalizes how markets with independent fundamentals can be linked through a shared constrained-investor class. Boyer, Kumagai, and Yuan (2006) and Broner, Gelos, and Reinhart (2006) document this portfolio channel across emerging markets. We provide a direct test where the two asset classes share no fundamental cash-flow linkage, identify the transmission through our direct/indirect decomposition, confirm it via amplification in equity-heavy fund families, and trace real consequences to local public finance. Chernenko and Sunderam (2012) show fund flows distort outcomes within segmented corporate credit markets. Our friction operates across fundamentally unrelated asset classes and imposes costs on public goods provision. Chodorow-Reich, Nenov, and Simsek (2021) document a related cross-market channel through household consumption to local labor markets. Our channel operates through fund liability structure, where the same stock-market shocks raise borrowing costs for local governments through fire-sale price spillovers. We complement the intermediary asset pricing literature (He and Krishnamurthy, 2013; Adrian, Etula, and Muir, 2014; Haddad and Muir, 2021) by identifying a liability-side channel. The intermediary carries no leverage and faces no binding regulatory constraint, yet transmits cross-market shocks through the demandable contracts it writes to its retail investor base. The open-end fund's contractual structure produces fragility analogous to the contractual externalities in Ozdenoren and Yuan (2017), where individually rational contract terms produce collectively excessive risk.

Third, while a growing literature documents the ownership structure of corporate bonds (Koijen and Yogo, 2023) and the resulting fragility within corporate bond funds (Goldstein, Jiang, and Ng, 2017; Falato, Goldstein, and Hortaçsu, 2021; Ma, Xiao, and Zeng, 2022), our setting differs in two ways. First, the shock originates in a fundamentally unrelated market, and the friction is priced in anticipation during normal conditions rather than triggered only by crisis selling. Second, our direct/indirect decomposition provides a sharp test of the mechanism. Only direct equity sensitivity drives the pricing wedge, whereas compensation for equity-correlated fundamental risk would load both components equally.

2 Data and Variable Construction

The sample includes all municipal bond transactions, excluding interdealer trades, from 2007 to 2021. Transaction data are from the Municipal Securities Rulemaking Board (MSRB). Eligible bonds must be tax-exempt and either fixed-rate or zero-coupon. U.S. territory bonds are excluded to ensure consistency in tax treatment and avoid the confounding effects of the Puerto Rico debt crisis. We exclude transactions within the first three months after issuance and the last three months before maturity, where trading dynamics differ from normal activity. To reliably measure *fund beta*, we restrict the sample to transactions involving bonds held by at least one open-end municipal bond fund in the previous month. Municipal bond characteristics are from the Mergent Municipal Bond Database. Federal and state tax rates are from taxfoundation.org. The final sample comprises 18,012,021 transactions, with customer trading volume of \$4.2 trillion. Mutual fund data are from Morningstar Direct.

Open-end mutual funds have become the dominant fund-based holder of municipal bonds over our sample period. Figure IA1 plots holdings shares from the Federal Reserve's Z.1 Financial Accounts. Open-end mutual funds held 11% (22%) of total municipal securities outstanding by the end of 2007 (2021). This doubling coincides with a roughly equivalent collapse in money market fund holdings, from 12% in 2008 to less than 3% in 2021. The money-market-fund decline reflects the SEC's 2014 and 2016 reforms imposing floating NAV and discretionary gates on prime and tax-exempt funds, a contractual-structure intervention we return to in Section 6.3. Cyclical variation is modest: the open-end share fell less than

1.5 percentage points during the 2008–09 crisis, the 2013 Taper Tantrum, and 2020Q1, fully reverting within a year. We revisit this near-acyclicality in Section 3.

2.1 Estimating fund beta

For each open-end muni fund, we estimate its return beta using a 24-month rolling regression of the *excess fund return* ($R_{f,m}$) on the *excess stock market return* (R_m^{stock}), in excess of the one-month Treasury bill rate, requiring at least 18 observations:[9]

$$R_{f,m} = \alpha + \beta \times R_m^{stock} + \varepsilon_{f,m}, \tag{1}$$

where f indexes funds and m indexes year-months.

Although municipal bond funds hold no equities, many exhibit positive stock market beta. This sensitivity arises primarily from the fund's liability structure rather than its portfolio. Funds whose investors redeem during equity declines (whether due to wealth effects, margin constraints, or portfolio-wide retrenchment) experience flow-driven NAV declines that covary with the stock market. Consistent with this liability-side interpretation, fund beta is uncorrelated with the fund's 12-month average return (Table IA2). Cross-sectional variation in fund beta thus reflects differences in investor composition and redemption behavior rather than portfolio choice, a point we confirm in the decomposition below.

The estimated β from Equation 1 captures the fund's total sensitivity to the aggregate stock market return. This sensitivity arises from the fund's direct exposure to the stock market and its indirect exposure through the municipal bond market:

$$\beta = \frac{\mathrm{d}R_{f,m}}{\mathrm{d}R_m^{stock}} = \underbrace{\frac{\partial R_{f,m}}{\partial R_m^{stock}}}_{\text{Direct fund beta}} + \underbrace{\frac{\partial R_{f,m}}{\partial R_m^{muni}} \frac{\mathrm{d}R_m^{muni}}{\mathrm{d}R_m^{stock}}}_{\text{Indirect fund beta}}, \tag{2}$$

where R_m^{muni} is the *excess muni market return* (Bloomberg Municipal Bond Index) in month m. To decompose fund beta, we estimate the following regressions:

$$R_{f,m} = \gamma + \beta_1 \times R_m^{stock} + \beta_2 \times R_m^{muni} + \varepsilon_{f,m}, \tag{3}$$

$$R_m^{muni} = \theta + \beta_{market} \times R_m^{stock} + \varepsilon_m \tag{4}$$

[9] The estimates are generally similar if using 12-month or 36-month rolling regressions. The stock market return is the value-weighted return on all CRSP stocks.

β_1 captures the fund's direct sensitivity to the stock market return, while the difference $\beta - \beta_1$ captures its indirect sensitivity. We refer to these as *direct fund beta* and *indirect fund beta*, respectively. Indirect fund beta can be expressed as the product of β_2 and β_{market}, representing the fund's sensitivity to the muni market return (*fund muni beta*) and the muni market's sensitivity to the stock market return (*aggregate muni beta*). At the bond level, *fund beta*, *direct fund beta*, and *indirect fund beta* are the par-weighted averages across all funds holding the bond as of the previous month.[10] Figure IA2 illustrates the beta decomposition.

Figure IA3 plots the quartiles of open-end muni funds' beta measures over time. *Fund beta* is close to zero on average but rises during stress periods, as does *aggregate muni beta*, while *fund muni beta* remains stable. The cyclicality in fund beta thus reflects shifts in the muni-stock correlation rather than funds' muni exposure.

We also measure *bond beta*, the sensitivity of a bond's monthly return to the stock (muni) market return, both in excess of the one-month Treasury bill rate. *Bond beta* is estimated using a 24-month rolling regression, requiring at least 12 observations. Due to limited trading activity in the muni market, this measure is available for only 56% of the full sample.

Bond-level fund beta measures are the primary explanatory variables in our analyses. To address measurement error in the beta estimates, we estimate the baseline regression by weighted least squares, weighting by the precision of each bond's beta estimate, which yields even stronger results (Table IA19). To address stale pricing from infrequent muni trading, we apply the Dimson (1979) procedure, with consistent findings.

2.2 Yield spreads

The main dependent variable in this paper is the tax-adjusted yield spread. For each trade, it is defined as the difference between the yield, adjusted for federal and state taxes, and the maturity-matched Treasury yield on the same day:

$$\frac{y_{b,t}}{(1-\tau_t^{fed})(1-\tau_{s,t}^{state})} - r_{b,t}, \tag{5}$$

[10] A potential bias is the bond's degree of mutual fund ownership. The main results are robust to assigning a "zero" fund beta to the portion of the offering not held by any fund and taking the weighted average across the full offering amount. In our calculation, we only include the portion of the offering amount held by mutual funds because if a bond is not held by any fund, it may still be exposed to the broader markets. Assuming "zero" fund beta would create inconsistencies between bond-level *direct fund beta* and *indirect fund beta*. We control for mutual fund holding (scaled by the bond's offering amount) in all specifications. Table IA19 reports weighted-result robustness with mutual fund holding as weight.

where τ_t^{fed} and $\tau_{s,t}^{state}$ represent the federal and state tax rates, respectively, in the year of trading. A higher yield spread indicates a lower bond price or a larger price discount relative to other bonds with similar characteristics.

2.3 Summary statistics

Table 1 presents the summary statistics for the main variables. Variable definitions are in Table IA1. All beta measures, except for *fund muni beta*, are small, with the sample mean and median close to zero. *Fund muni beta* (the beta measure with respect to the muni market) has a mean (median) of 0.97 (0.98), indicating that most bonds in the sample strongly comove with the aggregate muni market. Given the magnitude differences, we standardize all beta measures to zero mean and unit standard deviation.

The median transaction has a trading yield of 290 bps, a non-tax-adjusted (tax-adjusted) yield spread of 30 bps (228 bps), reflecting the low credit risk of investment-grade municipal debt. 36% of the sample consists of customer sales (versus purchases). Trading size is skewed. The mean par traded is \$0.23 million, while the median is only \$0.03 million. The median mutual fund holding, as a percentage of the bond's offering amount, is 23.77%.[11] The median offering amount is \$37.26 million. The median transaction occurs 4.18 years after the offering date and 15.18 years before the maturity date. The median bond rating is AA-.[12]

3 Baseline Results

3.1 Bond yield spread and fund beta

To investigate whether fund beta is associated with differential bond pricing, we use the following baseline specification:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t}, \tag{6}$$

where b indexes bonds, i indexes issuers, r indexes ratings, m indexes year-months, and t indexes trading days. The main explanatory variable is *fund beta*, the par-weighted average sensitivity to the stock market return across all funds holding the bond as of the previous

[11] Since bonds in the sample are held by at least one fund as of the previous month, this overestimates the magnitude of fund holdings in the full universe of all outstanding munis.

[12] Unrated bonds are not included in the rating statistics in Table 1 but are included in all main analyses, treated as a separate rating category.

month. Control variables include the natural logarithm of the par traded amount, the fraction of the bond's amount held by mutual funds, and other bond characteristics and fixed effects.[13] Standard errors are adjusted for clustering by both bond and trading day.

An advantage of this specification is the inclusion of issuer-by-date fixed effects ($\alpha_{i,t}$),[14] which absorb all time-varying characteristics specific to the municipality, including local economic conditions, changes in the tax base, and regional business cycles. The coefficient β is thus identified strictly from the cross-sectional variation in ownership structure among otherwise identical bonds. Time-series confounders, including the intermediary capital cycles captured by Adrian, Etula, and Muir (2014) and He, Kelly, and Manela (2017), are absorbed by the date dimension of the fixed effects. Combined with explicit controls for credit rating, maturity, callable status, and other bond characteristics, this specification isolates the effect of ownership structure from bond-level fundamentals. Our identification relies on multiple bonds from the same issuer trading on the same day, which restricts the sample to larger, more liquid issuers with multiple outstanding tranches. If anything, this biases our estimates toward zero. Smaller issuers with single bonds likely face even larger fragility premia due to lower liquidity and thinner markets. Our estimates should thus be interpreted as a conservative lower bound on the true Fragility Tax. Table 2 reports the results.

Column 1 of Table 2 shows that for each one-standard-deviation increase in fund beta, the bond trades at a higher tax-adjusted yield spread by 25 bps. This difference is economically meaningful, given that the sample's standard deviation (median) of yield spread is 223 (228) bps. We interpret this pricing wedge as a "fragility tax," compensation for the ownership risk associated with a fragile investor base.

One concern with this result is that *fund beta*, the sensitivity of fund return to stock market return, may simply proxy for other betas. In column 2, we examine *fund muni beta*, the sensitivity of fund return to the muni market return. The coefficient on *fund muni*

[13] Illiquid bonds may trade at a discount. Controlling for liquidity measures, such as Amihud, does not materially alter the results, as shown in Table IA19. However, it significantly reduces the sample size, given the infrequent trading in the muni market. While we do not directly control for bond liquidity in the main specifications, it is likely proxied by other observable bond characteristics.

[14] We identify issuers using the first six characters of bond CUSIPs. In some rare circumstances, one issuer may be associated with multiple six-character CUSIPs. For example, the state of Illinois is associated with "452146", "452147", ..., "452152", and "452153". Using the six-character CUSIP in the fixed effects allows for a stricter comparison among similar bonds from the same issuer (e.g., bonds issued in the same deal). Table IA19 shows the results are robust to using Mergent's *issuer_long_name* to identify issuers.

beta is similarly large at 28.42 bps. In columns 3–4, we use a direct measure for bond beta: the sensitivity of the bond's monthly excess return to the excess return on the stock (muni) market, estimated over the previous two years. Due to infrequent trading in the muni market, *bond (muni) beta* is available for 56% of the full sample. The coefficient on *bond beta* is small at 1.57 bps and is only significant at the 10% level, while that on *bond muni beta* is highly significant at 41.67 bps. These results suggest that, at the bond level, pricing is related to covariance with the muni market but not directly with the stock market. This is consistent with a transmission channel that operates through fund liabilities rather than through fundamental equity-muni covariance.[15] Finally, when all four beta measures are included in the same regression, the coefficient on *fund beta* remains significant at 17.87 bps.

Overall, Table 2 demonstrates a strong association between bond pricing and the sensitivity of holding funds' returns to stock market returns, beyond what is captured by 1) sensitivity to the muni market return and 2) the bond's own return beta.[16]

3.2 Fund beta decomposition

The baseline results establish that fund beta predicts yield spreads. But does this reflect ownership-driven fragility, or does fund beta proxy for unobserved bond-level risk that covaries with the stock market? We test against this alternative by decomposing fund beta into its direct and indirect components. As explained in Section 2.1, fund beta can be decomposed into *direct fund beta* (the direct sensitivity of fund returns to the stock market return) and *indirect fund beta* (the indirect sensitivity through the aggregate muni market). *Indirect fund beta* equals the product of *fund muni beta* (the sensitivity of fund returns to the muni market return) and *aggregate muni beta* (the sensitivity of the muni market return to the stock market return). If the yield spread compensated for equity-correlated fundamental risk (that is, if high-beta bonds were riskier along some dimension that covaries with the stock market), then *both* direct and indirect fund beta should predict yield spreads symmetrically. But they do not. Table IA2 reports the correlation between fund beta and

[15] We measure monthly bond return as the relative price difference between the two last-of-month customer trades in two consecutive months. Given the low trading activity and high transaction costs in the muni market, our measure is a noisy estimate for bond beta. Nonetheless, we aim to show that the effect of *fund beta* remains, even when controlling for *bond beta*.

[16] Control-variable coefficients have mixed signs. Bonds that are typically less risky (non-callable, insured) trade at higher yields within issuer-date cells, consistent with a selection effect in which liquidity-motivated traders concentrate in safer bond types.

its components. Direct fund beta captures the component of equity-market sensitivity of interest, after controlling for the indirect sensitivity through the muni market.[17]

Table 3 examines how trading yield spreads vary in response to each of the components of fund beta. Column 1 shows that a one-standard-deviation increase in *direct fund beta* is associated with a 17 bps higher yield spread. This is similar to the coefficient on *fund beta*, controlling for *fund muni beta*, in column 5 of Table 2. In contrast, there is no significant correlation between *indirect fund beta* and yield spread, as reported in column 2. Moreover, in column 3, where both beta measures are included, the coefficient on *direct fund beta* increases to 17.21, while the coefficient on *indirect fund beta* turns negative at -4.60, significant at the 5% level. This suggests that the results in Table 2 are primarily driven by the direct sensitivity to the stock market.

The remaining columns in Table 3 investigate why the association between *indirect fund beta* and yield spread is not significant and is even negative. There is a strong correlation between yield spread and *fund muni beta*, with the coefficient being 28.42. This is partially offset by the negative correlation between yield spread and *aggregate muni beta*.[18] For every one-standard-deviation increase in *aggregate muni beta*, trade yield spreads decline by almost 14 bps. Thus, although aggregate muni beta mechanically drives much of the variation in fund beta, it does not explain the Fragility Tax. The pricing effect is driven by fund-level heterogeneity in stock market sensitivity, not by market-wide muni-equity correlation. This decomposition provides a direct test against the alternative hypothesis that high-beta funds simply hold riskier bonds. If fund beta merely proxied for unobserved bond risk, both direct and indirect components should predict yield spreads symmetrically. Only direct fund beta drives the effect, while indirect fund beta is insignificant or even negative. This indicates the pricing wedge reflects fund-level fragility rather than bond-level fundamentals. This asymmetry pins down the channel through which equity shocks reach municipal bond prices while ruling out the most natural competing explanation.

[17] Fund beta is strongly correlated with *indirect fund beta* (correlation 0.93), while its correlation with *direct fund beta* is 0.59. *Indirect fund beta* is primarily driven by *aggregate muni beta* (correlation 0.96) rather than *fund muni beta* (correlation 0.11). This implies the order of importance in explaining a bond's *fund beta*: (i) muni-stock comovement, (ii) holding funds' direct stock betas, (iii) holding funds' muni betas.

[18] In column 5 of Table 3, issuer-by-date fixed effects are replaced with issuer-by-year-quarter fixed effects. This is because *aggregate muni beta* is an aggregate measure at the monthly frequency.

3.3 Fragility Tax over time

To illustrate that this effect is structural and not confined to crisis episodes, we plot the coefficient on fund beta over time. Figure 1 presents the estimated coefficients from a six-month rolling regression of the main specification. The effect of *direct fund beta*, in particular, varies significantly but remains positive even during non-crisis periods, such as 2019. This persistence is consistent with anticipatory pricing. That is, the market capitalizes expected fire-sale losses into current yields, so the premium is always positive but widens as stress approaches. This pattern distinguishes the Fragility Tax from supply-side frictions such as dealer inventory constraints, which emerge primarily during market dislocations (Li, O'Hara, and Zhou, 2024). It also operates alongside the viral selling propagation documented in Haddad, Moreira, and Muir (2021). That mechanism propagates across funds during stress episodes, whereas the Fragility Tax is priced into yields during calm periods, before any actual selling occurs. The structural vulnerability we identify is embedded in the open-end fund contract itself and does not require dealer markets to be disrupted. In crises, both channels operate simultaneously. When dealers are also capital-constrained, forced selling by redeemable funds meets thinner intermediation capacity, and the resulting price impact is larger, as reflected in the elevated coefficients we estimate during stress periods.

The cyclical pattern in the rolling coefficient is not driven by mechanical reshuffling of holders. Two pieces of evidence rule out this alternative. First, as shown in Figure IA1, the mutual fund share of municipal securities outstanding moves only 1 to 2 percentage points around its secular trend during the 2008 and 2020 stress periods, too small to mechanically generate the swings in the rolling coefficient on fund beta. Second, the dashed line in Figure 1 plots a counterfactual rolling coefficient estimated with shift-share fund beta. This measure combines each bond's holder weights from thirteen months prior with current fund-level betas, so that variation comes entirely from within-fund changes in fund beta rather than from changes in which funds hold the bond. The counterfactual traces the observed coefficient nearly perfectly throughout the sample. The cyclicality in the rolling coefficient therefore reflects within-fund changes in fund fragility, not changes in holder composition. We formalize this construction as a Bartik IV in Section 5.6.

3.4 Purchases versus sales

To further pin down the mechanism, we exploit the asymmetry between liquidity provision and consumption by separating customer purchases from sales. In Table IA3, we replicate the results from the previous tables. The effects are similar: the coefficient on *fund beta* is 24.98 for purchases and 24.54 for sales. However, the effects of direct and indirect betas differ between purchases and sales. For sales, the coefficient on *direct fund beta* is larger, while the coefficient on *indirect fund beta* is significantly more negative.

We further examine the differential effects on purchases and sales in Figure IA5, which plots the average yield spread for different fund beta groups. For each trading day, purchases (sales) are assigned to deciles based on the bond's fund beta. There are nonlinearities in the correlation between beta measures and yield spread, particularly for sales. For *fund beta* and *direct fund beta*, the lines are relatively flat at low beta levels but become steeper for higher deciles. For purchases, the relationships are relatively linear. These findings suggest that the main results may be driven by customer sales and by bonds with very high fund beta measures. We explore the mechanism underlying this asymmetry in the next section.

4 Mechanism: The Fragility Tax

The previous sections establish that bonds held by high-beta funds trade at a significant discount, driven by direct equity market sensitivity. We ask whether the open-end fund's redeemable liability structure generates this discount. If open-end funds act as passive conduits (transmitting equity market shocks to muni prices through their retail liability base), the pricing wedge should intensify when funds face greater redemption pressure, hold smaller cash buffers, and serve more retail investors.

4.1 Fund beta and net outflows

We find that funds with higher betas (greater sensitivity to stock market returns) tend to experience larger net outflows, scaled by fund TNA, controlling for lagged flows and lagged returns over the previous three months, as well as for fund and portfolio characteristics as of the last month (Table 4). The correlation between monthly aggregate net flows of open-end equity funds and municipal bond funds is -0.05 over the full sample but rises to 0.39 in months with S&P 500 returns in the bottom decile. This is consistent with the dash for cash explanation, where equity market declines generate synchronized outflows across fund types as investors retrench from all non-cash assets (Ma, Xiao, and Zeng, 2022). We include year-month fixed effects to compare the flows of funds with different betas in a given month.

In column 1 of Table 4, we find that when fund beta increases by one standard deviation, the fund experiences larger net outflows by 0.13% of fund TNA in the following month. This represents about 5% of the standard deviation of monthly net outflows in the fund-month sample. This positive association between fund beta and net outflows remains in column 2, which controls for *fund muni beta*.

Tables IA4 and IA5 document the fund-level and bond-level determinants of cross-sectional variation in fund beta. Both asset and liability-side characteristics matter. Specifically, funds holding longer-maturity, lower-rated, or uninsured bonds have higher betas, as do funds that experienced larger recent outflows and lower past returns. However, the pattern differs across components. For *direct fund beta* (the component that drives the Fragility Tax), past fund returns are the dominant predictor ($t = -21.5$), and the overall explanatory power is low ($R^2 = 0.36$), consistent with direct beta capturing hard-to-observe investor redemption behavior rather than portfolio composition. For *indirect fund beta*, portfolio characteristics explain most of the variation ($R^2 = 0.90$), as expected since this component reflects the fund's covariance with the muni market. The decomposition of beta determinants thus reinforces the decomposition of beta itself. That is, the pricing-relevant component is liability-driven.

We further decompose net outflows into expected and unexpected components in columns 3–6 of Table 4. For a given fund, expected net outflows are the predicted value from a 24-month rolling regression of net outflows on lagged net outflows and lagged returns. Unexpected net outflows are the difference between the realized and expected net outflows. A one-standard-deviation increase in *fund beta* is associated with 0.075% (0.060%) larger expected (unexpected) net outflows in the subsequent month.[19]

Table 4 focuses solely on fund flows for the immediate next month. In untabulated results, we find that *fund beta* also positively predicts net outflows, particularly the expected component, in the following months. In Table IA6, we further find that funds are more likely to experience smaller net outflows when the comovement between the muni market and stock market returns is higher. This explains why, in Table 3, there is a negative

[19] These two coefficients do not add up to the coefficient in column 1 of Table 4 due to winsorization.

association between bond yield spread and *aggregate muni beta*.

While the magnitude of realized flows (0.13%) may appear small relative to the yield impact (25 bps), this asymmetry reflects the extreme demand inelasticity of the municipal bond market. In a dealer-intermediated OTC market where inventory capacity has declined substantially (Adrian, Boyarchenko, and Shachar, 2017), market makers price the *risk* of forced selling, not just the realized flow, generating a multiplier effect as predicted by the inelastic markets hypothesis (Gabaix and Koijen, 2024).

A back-of-envelope calculation matches our 25 bps estimate to the muni market's demand inelasticity.[20] Consistent with this mechanism, Table IA7 shows that high-beta funds sell significantly more when VIX is high, confirming forced selling during stressed periods. This inelasticity amplifies the Fragility Tax: even modest flow shocks from retail liquidation generate large pricing distortions.

4.2 Flow pressure, cash buffers, and fund family equity orientation

If fund flows explain the pricing wedge, the association between fund beta and yield spread should strengthen when flow pressure is higher. Table 5 confirms this prediction. We measure flow pressure as follows:

$$\textit{Flow pressure}_{b,m} = \left(\sum\nolimits_{f} w_{b,f,m-1} \$\textit{Net outflow}_{f,m}\right) / \textit{Offering amount}_{b} \tag{7}$$

For the position in bond b held by fund f in month $m-1$, we use the portfolio weight to calculate the proportion of the fund's dollar net outflow in month m corresponding to that position. Flow pressure is defined as the sum of bond-b-specific net outflows across all funds holding the bond, scaled by the bond's offering amount. We use either realized fund flows or expected fund flows in month m.

[20] High-beta funds experience 0.13% larger monthly outflows (Table 4). Over a 10-year bond life, this cumulates to approximately 15.6% excess outflows. With a fire-sale discount of 1.5% per sale (in the range estimated by Coval and Stafford (2007), with Dinc, Erel, and Liao (2017) providing empirical evidence using market prices), the expected loss is approximately 23 bps, close to our 25 bps estimate. This suggests the yield spread reflects the capitalized present value of expected future flow-induced trading costs rather than contemporaneous flow pressure alone. Converting the 25 bps yield differential to price terms using a 10-year duration implies a price impact of approximately 2.5%, giving a flow-price multiplier of approximately 19 ($\approx 10 \times 0.25/0.13$). For comparison, Gabaix and Koijen (2024) estimate an equity market multiplier of 5. The muni multiplier is notably larger, reflecting OTC illiquidity and limited dealer risk-bearing capacity. This is a reduced-form approximation rather than a structural estimate directly comparable to Gabaix and Koijen (2024), providing an order-of-magnitude benchmark for the muni market's demand inelasticity.

Column 1 of Table 5 shows that bonds trade at higher yield spreads when their flow pressure, measured in the same month, is higher. A one-standard-deviation increase in flow pressure is associated with a 3.78 bps higher yield spread. This is consistent with the literature, which finds that flow-induced trading leads to price impact.[21] In column 2, the coefficient on the interaction between fund beta and flow pressure is statistically significant at 1.43. A one-standard-deviation increase in flow pressure is associated with about a 5% stronger correlation between fund beta and bond yield spread. This finding supports the flow-based explanation.

The results should also be stronger for customer sales, which are more likely to be flow-driven and associated with larger price discounts than customer purchases. This is indeed the case in column 3 of Table 5, where we include the triple interaction between fund beta, flow pressure, and an indicator for customer sales (versus purchases). The coefficient on the triple interaction is positive at 1.26. That is, the effect of flow pressure on the relation between fund beta and bond yield spread is more than 100% stronger for sales than for purchases ($1.16 + 1.26 = 2.41$ versus 1.16). The friction reflects the greater liquidation pressure facing high-beta funds, which must offload assets into a constrained market.

In columns 1–3 of Table 5, flow pressure is measured using the realized flows in the same month as the transaction. To address the potential look-ahead bias this may cause, in columns 4–6 we use month-m expected fund flows, estimated using information up to month $m - 1$. The main coefficients remain significant and similar in magnitude, suggesting that bonds held by high-beta funds trade at a discount in anticipation of outflows.

Funds may use cash and liquid assets to meet outflows to avoid selling bonds at potentially high discounts (Chernenko and Sunderam, 2016, 2020). Supporting the liquidity management channel, Panel A of Table 6 shows that the main effect is weaker when the funds holding the bonds have larger cash buffers. We define *Cash* as the par-weighted average cash-to-assets ratio across all funds holding the bond. When *Cash* decreases by one stan-

[21] For evidence on flow-induced price impact, see, e.g., Edelen and Warner (2001), Coval and Stafford (2007), Greenwood and Thesmar (2011), Lou (2012), Ma, Xiao, and Zeng (2022), and Li, O'Hara, and Zhou (2024). Also examining same-issuer bonds exposed to differing outflows, Choi et al. (2020) find little evidence of flow-induced price impact in the corporate bond market. The difference between their results and ours can potentially be attributed to the corporate bond market being relatively more liquid than the muni market (see Bessembinder et al., 2018). Another difference is that Choi et al. (2020) use issuer-by-quarter fixed effects, while we use issuer-by-date fixed effects in our analysis.

dard deviation, the positive association between yield spread and fund beta increases by 2.16 bps. This is primarily driven by *direct fund beta*. This supports the liquidity-driven fire sale explanation and contradicts the fundamental risk explanation. One might worry that cash holdings proxy for conservative fund style rather than a causal buffer; the state-dependence of the interaction across volatility regimes, documented next, addresses this concern.

To further disentangle the liquidity channel from fund style, we exploit time-series variation in market stress. If cash buffers function as a liquidity backstop, their mitigating effect should be strongest during periods of high market fragility. In columns 3–4 of Table 6, we split the sample based on the daily value of the CBOE Implied Volatility Index (VIX). We find that the negative interaction between Fund Beta and Cash is significantly stronger during high-VIX periods, confirming that the buffering mechanism is state-dependent and tied to market stress. The state-dependence is substantial. During high-VIX periods, the fund beta coefficient is 34.7 bps, while during low-VIX periods it is only 2.4 bps and statistically insignificant. The Fragility Tax is thus substantially larger during stress, when fire-sale risk is most salient. The level of the wedge itself remains positive even in calm periods: in the broader rolling regression (Figure 1), the coefficient on fund beta is positive in calm 2019 and rises to approximately 35 bps in high-VIX months. What is concentrated in stress is the *sensitivity* of the wedge to fund-level cash buffers, not its baseline level. The positive point estimate in calm periods is consistent with anticipatory pricing: the yield premium reflects the market's assessment of future fire-sale risk, which rises with the probability of stress.

Our portfolio channel of contagion predicts that the Fragility Tax should be stronger when a bond's holding funds belong to fund families that manage a larger share of equity funds. In such fund families, investors are more likely to hold both equity and municipal bond funds, so equity market downturns are more likely to trigger redemptions from the bond fund through cross-fund rebalancing. Panel B of Table 6 tests this by interacting fund beta with *Fund family's equity fund share*, defined as the par-weighted average fund-family-level equity fund share across all funds holding the bond. Column 1 confirms that the interaction is positive and significant: a one-standard-deviation increase in the fund family's equity fund share amplifies the yield spread–fund beta relation by 1.24 bps. Column 2 shows that this amplification is driven by direct fund beta. Columns 3–4 show that the amplification is concentrated in high-VIX periods (2.13 bps), while the interaction is indistinguishable from zero in calm markets. These results support the view that equity market stress propagates to municipal bond prices through common fund family ownership.

4.3 Mutual fund trades and yield spreads

We provide further evidence supporting the flow-induced trading explanation in Table 7, which follows a similar structure to Table 5 but replaces *flow pressure* with an indicator for mutual fund trades.[22] Compared to trades by other market participants, mutual fund trades exhibit higher yield spreads by 15 bps. Additionally, the association between fund beta and yield spread is stronger by nearly 6 bps for fund trades compared to other trades, particularly for sales. Columns 4–6 impose an even stricter comparison by including bond-by-date fixed effects. While the main coefficient estimates are smaller in magnitude, they remain statistically significant. For the same bond on the same day, mutual fund trades have yield spreads that are 7 bps higher and exhibit a 3 bps stronger association between fund beta and yield spread. This effect is entirely driven by customer sales.

An alternative interpretation is that dealers widen spreads for high-beta funds not because of anticipated fire sales, but because they recognize these funds as urgent or informed traders, a standard adverse selection story. We argue this interpretation reinforces, rather than contradicts, our mechanism. That is, dealers widen spreads because they anticipate high-beta funds will need liquidity urgently during stress. However, we can distinguish between information-based and liquidity-based adverse selection. Three pieces of evidence favor the liquidity channel. First, the effect is stronger during high-VIX periods (Table IA22), pointing to time-varying liquidity needs rather than persistent information asymmetry. Second, the effect is attenuated when funds hold larger cash buffers (Table 6); information content should not depend on cash holdings. Third, the effect is stronger for funds with higher retail share (Table IA8); retail investors are typically characterized as noise traders, not informed traders.

Overall, our findings support the flow-induced trading explanation. That is, the market anticipates potential flow-induced sales of bonds held by high-beta funds and demands a discount, particularly when these bonds are sold. While prior literature has documented flow-induced price impact for munis, we show that the impact is not uniform. Specifically, bonds held by high-beta funds experience significantly stronger effects. The amplification

[22] To identify mutual fund trades, we apply the algorithm of Chernenko and Doan (2024). Their algorithm explains more than 90% of all muni fund holding changes and matches 85% of holding changes (excluding those due to bond events or fund mergers) to actual transactions in MSRB data. We identify 406,604 trades by open-end municipal bond funds, accounting for 2.3% of all trades in the full sample.

when holding funds belong to equity-heavy fund families (Table 6) provides direct support for the portfolio channel. The friction is stronger when investors are more likely to hold both equity and muni funds within the same family.

4.4 The role of retail investors

The portfolio channel we propose operates through household investors who liquidate across asset classes during equity downturns. If this mechanism drives the Fragility Tax, the effect should be stronger for bonds held by funds with a larger retail investor base. We now examine whether the Fragility Tax is driven by retail or institutional share classes. In Table IA8, we calculate the TNA of the fund attributable to retail share classes for each fund-month. *Retail share* is defined as the par-weighted average share of retail share classes across all funds holding a given bond.

Table IA8 shows that the baseline effects are stronger when the funds holding the bond have a higher share of retail classes. The effect increases by 1.91 bps per standard deviation of *Retail share*, driven by both direct and indirect fund betas, with the former playing a significant role. The stronger results associated with retail share classes provide further support for the hypothesis that fund-level characteristics, such as investor composition, influence bond prices. If bond fundamentals were the only explanation, bond prices would not depend on who holds them. Prior work documents that retail investors are more prone to behavioral biases and sentiment-driven trading than institutional investors (Campbell, 2006; Frazzini and Lamont, 2008). Consequently, they are more sensitive to short-term performance and more likely to redeem during equity market downturns (Goldstein, Jiang, and Ng, 2017). By showing that the effect is stronger on bonds held by funds with high retail ownership, we provide evidence that the friction originates in the retail investor base. Retail investors are more likely to liquidate muni fund holdings during equity downturns (whether due to wealth effects and margin constraints or to sentiment-driven overreaction), making high-beta funds with large retail share classes particularly fragile.

In column 3 of Table IA8, we further test whether the effect is amplified by sentiment, as proxied by the monthly University of Michigan Consumer Sentiment Index. The Fragility Tax is stronger by 19.68 bps for every one-standard-deviation decrease in consumer sentiment. In column 4, we examine a behavioral bias that can affect trading: overextrapolation. We borrow the measure *degree of extrapolative weighting in investors' beliefs* (DOX) from

Cassella and Gulen (2018). A high DOX indicates that investors have strong extrapolative beliefs about stock market returns. A one-standard-deviation increase in DOX is associated with a 6.89 bps increase in the Fragility Tax, equivalent to 25% of the unconditional effect.

Together, the results in Table IA8 show that retail investors, more susceptible to both sentimental and extrapolative trading than institutions, drive the main effects.[23] More broadly, the fire-sale discounts we document align with the theoretical framework of Shleifer and Vishny (1992, 2011), where forced sellers face steep price concessions. The DOX result suggests that selling pressure is amplified by belief-based overreaction, creating a dislocation where retail liquidity demand spikes during market downturns, when arbitrageurs are most constrained. This redemption behavior implies an asymmetry. Specifically, retail investors redeem when stocks fall but do not necessarily pour capital into muni funds when stocks rise. The baseline mechanism (cross-asset liquidation driven by wealth effects and borrowing constraints) operates even among fully rational investors. The concentration of the effect in high-beta funds with high retail share, its amplification during periods of high extrapolative expectations, and its sensitivity to consumer sentiment indicate that behavioral forces substantially magnify the rational channel.[24]

We provide detailed evidence for this retail fragility channel, extending the within-fund reallocation analysis of Ma, Xiao, and Zeng (2022) from corporate bonds to the muni setting. Table IA9 uses a within-fund analysis comparing retail versus institutional share classes. We find that retail flows exhibit significant concavity. That is, they are far more sensitive to negative returns than institutional flows. Conversely, institutional capital is sticky on the downside but chases returns on the upside. This supports the interpretation that the fragility originates specifically from the fragile nature of the retail liability base.

Indeed, the upside-downside beta decomposition provides a direct test of this asymmetry. Table IA10 decomposes both direct and indirect fund beta into their upside and downside components, estimated separately using months when the excess stock market return is

[23] Our findings regarding extrapolation are in the spirit of the extrapolative expectations framework of Greenwood and Shleifer (2014), Barberis et al. (2015), and Cassella and Gulen (2018), the noise trader framework of De Long et al. (1990), and the limits to arbitrage model of Shleifer and Vishny (1997).

[24] Peterson (2024) finds the flow-performance relation in U.S. municipal bond mutual funds is linear, with retail investors less performance-sensitive than institutional investors, and concludes that MBMFs do not promote run-risk. Our channel is different. Retail investors redeem in response to equity-market declines, not own-fund performance, generating cross-market fragility.

above or below zero. If the Fragility Tax reflected symmetric compensation for equity-correlated risk, upside and downside betas should load equally. Instead, the yield spread is significantly more sensitive to *downside* direct fund beta than to *upside* direct fund beta, as expected if the fire-sale channel operates primarily through equity market declines. The pattern reverses for indirect fund beta, where upside loadings dominate. This is further evidence that the direct and indirect components capture fundamentally different economic forces. This asymmetry is difficult to reconcile with a risk-premium interpretation but follows naturally from a mechanism where equity declines trigger cross-asset liquidation (through both rational portfolio rebalancing and behavioral overreaction) during market downturns.

4.5 Why does the Fragility Tax persist? Limits to arbitrage

The yield differentials we document are large enough that one might expect arbitrageurs to step in, buying cheap bonds held by high-beta funds and compressing the pricing wedge. They do not, and the reason is that the municipal bond market combines several frictions that impede arbitrage activity, a natural setting for the limits-to-arbitrage framework of Shleifer and Vishny (1997).

The most immediate friction is trading costs. Municipal bonds trade over the counter through dealers who charge markups that are large relative to the yield differentials at stake, particularly for small or illiquid issues (Harris and Piwowar, 2006; Green, Hollifield, and Schürhoff, 2007). Even a well-resourced trader faces a tax clientele barrier. Specifically, muni bonds are most valuable to high-bracket investors, and anyone outside that clientele earns an after-tax yield that may not cover the round-trip cost. Short-selling, which would allow a relative-value trade between overpriced and underpriced bonds, is effectively unavailable. Because we argue the Fragility Tax reflects *under*pricing of bonds held by fragile funds, the absence of a short-sale mechanism is especially relevant. It is almost impossible to bet on convergence from the other side.

The implication is that the marginal buyer of a bond held by a high-beta fund is typically another dealer or fund, not an unconstrained arbitrageur with a long horizon. Our evidence that the pricing wedge grows *larger* during stress periods (Table 6) fits this picture. Specifically, the same market dislocations that widen the Fragility Tax also reduce the risk-bearing capacity of the traders who might otherwise correct it, exactly the amplification mechanism in Shleifer and Vishny (1997).[25] We discuss the welfare implications of this persistent friction and potential policy responses in Section 6.3.

5 Identification

In the main results, we include issuer-by-date fixed effects, effectively controlling for unobservable issuer quality. While the decomposition results in Section 3.2 weigh against a pure fundamentals explanation, this section presents a series of additional identification tests that address remaining concerns about endogeneity and selection.

5.1 Fund identity

A concern with the main analysis is the lack of investor identity; investor heterogeneity, such as trading styles or trading needs, may not be properly controlled. In Table IA11, we restrict the sample to the mutual fund trades identified in Section 4.3 and include fund-by-month fixed effects. This specification compares bonds traded by the same fund in the same month, fully absorbing any fund-level characteristics, including selection preferences, risk appetite, and time-varying liquidity needs. If high-beta funds simply preferred riskier bonds, this selection would be absorbed by the fund-month fixed effect. However, the coefficient on bond-level fund beta remains significant across specifications.

Columns 4–6 impose a stricter test by adding bond fixed effects, comparing the execution prices of the *same bond* traded by different funds in the same month. We find that high-beta funds trade at significantly higher yield spreads than low-beta funds. This pricing discount cannot reflect bond-specific information asymmetry (the bond is identical), but reflects dealer recognition that high-beta funds face greater pressure to trade, consistent with fire-sale theories predicting that urgent sellers face price concessions (Shleifer and Vishny, 1992, 2011).

5.2 Open-end versus closed-end funds

Unlike open-end funds (OEFs), closed-end funds (CEFs) raise capital through an initial offering and then trade on an exchange like stocks. They do not issue or redeem shares on a daily basis and are therefore less susceptible to redemption risk compared to open-end funds.

[25] Asymmetric amplification of this kind also arises in Yuan (2005), where the borrowing constraint on informed arbitrageurs is itself price-dependent and tightens as prices fall.

If the main results are explained by the flow risk channel, we would expect the effect to be weaker for closed-end funds, making them a clean counterfactual.

Consistent with this hypothesis, Table IA12 shows that in the subsample of bonds held by *both* OEFs and CEFs, a one-standard-deviation increase in open-end fund beta is associated with a 55.65 bps increase in yield spreads. This is larger than the baseline estimate in Table 2 due to the smaller sample. The coefficient on closed-end fund beta is smaller at 27.80. The difference widens in column 5, where both beta measures are included simultaneously: 53.27 for open-end fund beta and 16.13 for closed-end fund beta.

CEFs and OEFs share a similar retail client base but differ in liability structure. Specifically, CEF investors cannot redeem at NAV. The CEF beta coefficient therefore captures the baseline effect of correlated retail beliefs on prices, a sentiment channel (Lee, Shleifer, and Thaler, 1991). The difference between the OEF and CEF coefficients ($53.3 - 16.1 \approx 37$ bps, $t = 5.42$) isolates the incremental friction from the redeemable liability structure, the flow channel that CEFs lack. This 37 bps gap is our cleanest estimate of the pure flow-driven component of the Fragility Tax. It is more than twice the sentiment component, implying the liability structure of the intermediary matters more than the beliefs of its investors. The pattern is reinforced by Table IA8. The OEF effect intensifies during periods of low sentiment and high extrapolative expectations, when retail investors are most likely to redeem.

5.3 Ownership turnover and selection

To address the concern that fund beta simply proxies for unobservable bond characteristics (selection), we exploit within-bond variation in ownership turnover. We decompose the level of a bond's fund beta ($\mathit{Fund\ beta}_{b,t}$) into its lagged level ($\mathit{Fund\ beta}_{b,t-1}$) plus the components of its change:

$$\begin{aligned}\mathit{Fund\ beta}_{b,m} = {} & \mathit{Fund\ beta}_{b,m-1} \\ & + \underbrace{\sum_f (w_{b,f,m} - w_{b,f,m-1})\beta_{f,m-1}}_{\text{Active}} + \underbrace{\sum_f w_{b,f,m-1}(\beta_{f,m} - \beta_{f,m-1})}_{\text{Passive}} + \underbrace{\sum_f \Delta w_{b,f,m}\Delta\beta_{f,m}}_{\text{Cross-Term}}\end{aligned} \tag{8}$$

We then regress yield spreads on these four components. This specification allows us to isolate the price impact of *active ownership turnover* (the Active component) from the persistent stock of ownership risk (the Lagged Total Beta).

In Table IA13, we find that the "Active" component (the change in ownership towards high-beta funds) is positively and significantly associated with yield spreads ($t = 11.07$), controlling for the lagged level of total fund beta. While the magnitude of the coefficient on the active component is smaller than that of the persistent stock of ownership risk (Lagged Total Beta), the high statistical significance confirms that ownership structure affects pricing independently of bond fundamentals. The direction of causality is also clear. When high-beta funds actively acquire a bond, its yield spread subsequently widens relative to peers, indicating that fragile ownership imposes costs on the asset itself.

In Table IA14, we further show that the Fragility Tax is stronger when holding funds have more dispersed portfolios, i.e., when fund beta is a poor proxy for any specific bond's characteristics. This approach also addresses the "reaching for yield" hypothesis (Greenwood and Hanson, 2013; Becker and Ivashina, 2015; Choi and Kronlund, 2018). If high-beta funds simply passively held riskier bonds to boost yields, the effect would be fully captured by the portfolio characteristic dispersion control. Active turnover predicts yield changes, suggesting the friction is dynamic and flow-driven.

5.4 Matched-sample analysis

A remaining concern is that, even within an issuer-date cell, bonds may differ systematically in characteristics correlated with both fund beta and yield spreads. To address this, we implement a matched-sample design that absorbs all observable bond heterogeneity. For each trading day, we assign transactions to quintiles based on all continuous control variables (par traded, mutual fund holding, offering amount, bond age, bond maturity, and turnover) and form matched groups of transactions sharing identical quintile assignments and all categorical characteristics (credit rating, callability, general obligation/revenue classification, insurance, credit enhancement, and bank qualification). All specifications include matched group-by-date fixed effects, which absorb any pricing variation attributable to observable bond characteristics. In the most demanding specification, we additionally include issuer-by-date fixed effects.

Table 8 reports the results. In columns 1–2, with only matched group-by-date fixed effects, the coefficient on fund beta is 26.92 ($t = 18.51$), virtually identical to the 25 bps baseline estimate in Table 2. Columns 3–4 impose the most demanding specification by combining matched group-by-date fixed effects with issuer-by-date fixed effects. The coefficient on fund beta attenuates to 14.12 ($t = 14.68$) but remains highly significant. This estimate provides a conservative lower bound on the Fragility Tax. It survives after absorbing every observable bond characteristic through non-parametric matching *and* all time-varying issuer-level heterogeneity.

The decomposition into direct and indirect components is informative. Indeed, under the most demanding specification (column 4), the coefficient on direct fund beta is 10.09 ($t = 22.67$), confirming that the direct equity sensitivity channel is robust to the most stringent controls. The coefficient on indirect fund beta is -3.12 ($t = -2.56$), consistent with the baseline pattern in Table 3. Without issuer-by-date fixed effects (column 2), the indirect fund beta coefficient is positive and significant at 13.37 ($t = 9.16$). The sign reversal when issuer-by-date fixed effects are added indicates that indirect fund beta captures issuer-level variation in aggregate muni market sensitivity, variation absorbed by issuer-date fixed effects, further supporting the interpretation that only the direct component reflects fund-level fragility.

5.5 Exposure to the Puerto Rico debt crisis

We exploit the Puerto Rico debt crisis in the mid-2010s as an exogenous shock to fund-level risk. This is widely considered the largest municipal bond default in U.S. history: in 2018, Puerto Rico owed more than $70 billion in public-sector debt, compared to the $18 billion debts of the city of Detroit in the second-largest case.[26]

Our difference-in-differences analysis examines the period from 2012Q4 to 2014Q4, with the treatment defined as the exposure of the bond's holding funds to Puerto Rico bonds. Even though Puerto Rico's credit rating was downgraded to non-investment grade in early 2014, several warnings had emerged the year prior.[27] Despite the relatively small size of Puerto Rico bonds, a large number of municipal bond funds had exposure to these bonds, thanks to the triple exemption from federal, state, and local taxes on bond interest (CNBC,

[26] https://www.ebsco.com/research-starters/politics-and-government/puerto-ricos-debt-crisis-overview/.

[27] See, for example, Barrons (August 2013), Kiplinger (September 2013), InvestmentNews (October 2013), and Reuters (February 2014). A timeline of the Puerto Rico debt crisis is available at Jubilee USA. Figure IA6 shows that Google search interest in the Puerto Rican government debt crisis jumped in early October 2013. A key catalyst was the City of Detroit's bankruptcy filing in July 2013, which effectively ended the implicit federal guarantee for municipal issuers (the so-called "Treasury Put" (Chirinko, 2023)) and intensified market concerns about Puerto Rico's fiscal sustainability (see also Chari, Leary, and Phan, 2025).

January 2014). The deterioration in Puerto Rico bond quality could negatively affect the holding funds and, as a result, other bonds held by the same funds.

While this period somewhat overlaps with the Taper Tantrum, the impact on Puerto Rico bonds is significantly larger than that on other bonds. In 2013Q3 alone, the S&P Municipal Bond Puerto Rico Index declined 14.25%, compared with 2.93% (0.36%) in the S&P Municipal Bond High Yield (Investment Grade) Index. This lends support to using the holding funds' exposure to Puerto Rico bonds as a shock to fund risk in explaining the prices of other underlying non-Puerto Rico bonds. The key to our identification is the randomness of the treatment: the triple-tax exemption meant Puerto Rico bonds were held by a wide cross-section of funds (both national and single-state), so high exposure was not necessarily correlated with a preference for high-yield or risky assets in the rest of the portfolio. We thus argue that the shock to the funds was plausibly orthogonal to the fundamental quality of their mainland holdings, a claim we support with evidence that non-Puerto Rico bonds held by high-exposure funds maintained stable credit ratings throughout the crisis (Figure IA8). If high Puerto Rico exposure simply proxied for a fund's general appetite for credit risk, we would expect the non-Puerto Rico holdings of these funds to underperform even absent the Puerto Rico shock. The stability of their credit ratings suggests this is not the case.

As of June 2013, exposure to Puerto Rico bonds varied substantially across muni funds, with the most exposed funds holding more than 65% of their portfolios in Puerto Rico debt. These funds experienced severe outflows over the subsequent year, while aggregate net outflows across all open-end muni funds were only 4.6%.[28]

We measure a bond's exposure to Puerto Rico bonds as follows:

$$\textit{Puerto Rico exposure}_{b,m-1} = \left(\sum\nolimits_f w^{PR}_{f,m-1} \textit{Par held}_{b,f,m-1}\right) / \textit{Offering amount}_b, \tag{9}$$

where $w^{PR}_{f,m-1}$ is fund f's portfolio share of Puerto Rico bonds in month $m-1$. This measure adjusts each position in bond b held by fund f in month $m-1$ by the fund's exposure to Puerto Rico bonds. *Puerto Rico exposure* is the sum of bond b's adjusted par amount held by all open-end muni funds, scaled by the bond's offering amount.

Figure 2 illustrates the quarter-by-quarter sensitivity of fund beta and net outflows to

[28] The Franklin Double Tax-Free Income Fund, with more than 65% exposure to Puerto Rico bonds, experienced net outflows of 40% during July 2013–2014, with TNA declining from $633 million to $286 million.

Puerto Rico exposure, measured as of 2012Q3, at the fund level between 2012Q4 and 2014Q4. For fund beta, the coefficients are generally negative in the early quarters, increase in the latter half of 2013, and remain elevated in 2014. Indeed, the pattern for fund net outflows is even more pronounced. Beginning in 2013Q3, a one-standard-deviation increase in Puerto Rico exposure is associated with an increase in net outflows of 0.3% to 0.4%. To provide context, the sample standard deviation of monthly net outflows during this period is 2.2%.

The sharp increase in the coefficients supports using *Puerto Rico exposure* to establish that *fund-level* risk impacts the pricing of the underlying bonds, even though the fundamentals of these bonds do not change. First, our main sample excludes all U.S. territory bonds. Second, the Puerto Rico debt crisis would not be fundamentally related to other bonds from non-Puerto Rico issuers. Figure IA7 illustrates that, in the main sample, Puerto Rico bonds experience a sharp decline in credit ratings beginning in 2014, while the ratings of other bonds remain stable. Figure IA8 provides further support by showing that the weighted-average credit rating of non-Puerto Rico bonds held by funds with high exposure to Puerto Rico debt remained stable relative to those held by low-exposure funds throughout the crisis period. Third, the inclusion of issuer-by-date fixed effects allows us to test the impact of *Puerto Rico exposure* by comparing bonds from the *same issuer* traded on the same day.

We estimate the association between a bond's yield spread and its holding funds' exposure to Puerto Rico bonds, measured as of 2012Q3, using the following specification:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \sum_{\tau=2012Q4}^{2014Q4} \beta_\tau \times \mathbb{1}(t \in \tau) \times \textit{Puerto Rico exposure}_{b,2012Q3} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t}, \tag{10}$$

Because the treatment period partially overlaps with the 2013 Taper Tantrum and the City of Detroit's bankruptcy, all specifications control for fund duration beta (the sensitivity of fund returns to changes in the 10-year Treasury rate) and fund-level Detroit exposure, both interacted with quarter indicators. The yield spread specification additionally excludes bonds from Detroit issuers. These controls ensure that the estimated Puerto Rico exposure effect captures the idiosyncratic Puerto Rico shock rather than heterogeneous interest rate sensitivity or correlated exposure to the Detroit default. Figure 3 reports the estimated coefficients from specification 10. We report the full regression results from both Figures 2 and 3 in Table IA15. The coefficient jumps sharply during 2013Q3–2014Q1: a one-standard-deviation increase in *Puerto Rico exposure* is associated with yield spreads that are 6–11 bps higher. After that, the magnitude of the coefficient declines, but it remains statistically significant and is larger than that observed in the early quarters.

To formally assess the parallel trends assumption underlying this analysis, we conduct joint F-tests on the pre-treatment coefficients. For fund-level net outflows (Figure 2b), we fail to reject the null that the pre-treatment coefficients (2012Q4–2013Q2) are jointly zero ($F = 0.99$, p-value = 0.40), supporting the parallel trends assumption. It is similar for yield spreads (Figure 3): $F = 0.42$, p-value = 0.74. Importantly, the identifying variation is the discontinuous increase beginning in 2013Q3 (when the Puerto Rico crisis intensified) rather than a continuation of pre-existing trends.

Overall, this analysis provides independent quasi-experimental support for the importance of *fund-level* risk (induced by Puerto Rico default risk) in explaining underlying bond pricing, beyond the explanatory power of the bond fundamentals themselves.

5.6 Shift-share instrumental variable analysis

As a final identification strategy, we instrument fund beta using a shift-share (Bartik) design. The instrument exploits predetermined ownership structure (fund holdings from 13 months prior) combined with current fund-level equity betas:

$$\textit{Fund beta (shift-share)}_{b,m-1} = \sum_{f} s_{b,f,m-13} \times \beta_{f,m-1}, \tag{11}$$

where $s_{b,f,m-13}$ is fund f's ownership share of bond b held 13 months ago and $\beta_{f,m-1}$ is the fund's equity beta from the prior month. In the framework of Borusyak, Hull, and Jaravel (2022), identification comes from the fund-level beta shocks being as-good-as-randomly assigned conditional on the predetermined ownership shares. Because these shocks reflect portfolio-wide equity sensitivity (determined by fund-level asset allocation, retail investor composition, and duration positioning), they are plausibly uncorrelated with any individual bond's unobservable characteristics.

Table IA16 reports the secondary market results. The first-stage F-statistic is 11,316, and the shift-share instrument explains 84% of the variation in current fund beta. The IV estimate of 30.7 bps exceeds the OLS estimate of 25.8 bps, consistent with attenuation bias from measurement error in fund beta. With issuer-by-date fixed effects, the exclusion restriction is particularly clean. All issuer-level characteristics, including credit rating, are absorbed, so the instrument can affect yields only through the fragility channel.

Tables IA17 and IA18 extend the shift-share analysis to the primary market, whose baseline results are reported in the next section. For offering yield spreads, the IV estimate is 9.3 bps versus 6.5 for OLS ($F = 405$). For county-level issuance amounts, the IV estimate is -56.8 per capita versus -49.6 for OLS ($F = 2{,}710$). In both cases, IV exceeds OLS, consistent with attenuation bias. The primary market specifications rely on county-by-month or state-by-year fixed effects, which absorb less unobserved heterogeneity than issuer-by-date fixed effects; we therefore interpret these results as corroborating evidence rather than standalone causal estimates.

6 Real Economic Consequences

6.1 The cost of local financing

The Fragility Tax may not be limited to secondary market trading. A number of papers have shown that information asymmetry and (expected) liquidity in the secondary market determine corporate bond issuance in the primary market.[29] This effect is potentially more pronounced in the municipal bond market, where bonds are generally illiquid and do not trade frequently. We document a similar spillover effect in our setting. When a municipal bond is issued, its offering yield spread is positively associated with the average fund beta of the issuer's outstanding bonds as of the previous month. Table 9 reports the results.

Table 9 examines a sample of municipal bond issues between 2007 and 2021. The main explanatory variable is issuer-level *fund beta*, which is the weighted average bond-level *fund beta* across the issuer's outstanding bonds as of the month preceding the issuance month, with weights based on each bond's offering amount. By construction, the sample is limited to bonds issued by issuers that have at least one outstanding bond held by municipal bond funds as of the previous month. The dependent variable is the offering yield spread, defined as the offering yield minus the maturity-matched Treasury yield on the offering date. In columns 4–6 of Table 9, we further adjust the offering yield spread for federal and state taxes. In the strictest specification, we incorporate county by year-month fixed effects. This

[29] See, e.g., Qi and Wang (2016), Davis, Maslar, and Roseman (2019), Nikolova, Wang, and Wu (2020), and Brugler, Comerton-Forde, and Martin (2022).

allows us to compare the offering yield spread of bonds issued in the same county and around the same time but associated with different levels of *fund beta*.

Table 9 shows that, for every one-standard-deviation increase in issuer-level *fund beta*, the offering yield spread increases by 6–14 bps. Indeed, the effect is strongest at 13.70 bps in column 5, which examines tax-adjusted yield spreads of bonds issued in the same county and during the same month. A back-of-the-envelope calculation based on the aggregate issuance amount of \$3.4 trillion and the (issuance) sample average duration of 8 years translates this estimate to higher financing costs of \$37 billion ($= 8 \times \$3,400\text{b} \times 0.137/100$) over the sample period, or \$2.5 billion annually. We note that this represents an upper bound, as it assumes the entire yield spread differential is causally attributable to fund fragility. Under more conservative assumptions (for example, if only half of the effect is causal), the implied cost would be approximately \$19 billion (\$1.2 billion annually). Even under conservative assumptions, the magnitude is economically significant relative to typical municipal infrastructure budgets. Columns 3 and 6 decompose the effect. The coefficient on issuer-level *direct fund beta* is significant at 6.62 bps, while the coefficient on *indirect fund beta* is smaller at 3.45 bps and is not statistically significant.

This wedge is identified across issuers within the same county-month. Adelino et al. (2026) document a 19.5 bps reduction in average issuance yields, using a Morningstar rating methodology change to instrument for fund flows. That effect identifies a time-series capital-supply channel. The Fragility Tax operates through a distinct, cross-sectional channel: holder fragility rather than aggregate capital supply. Section 7 reports the controls that separate the two channels.

Consider a mid-sized county issuing \$200 million in 20-year general obligation bonds with a duration of 10 years. A 14 bps increase in offering yield spread translates to approximately \$3 million in additional costs over the life of the bonds. These are resources diverted from public services to compensate investors for ownership risk unrelated to the issuer's creditworthiness. The 14 bps yield differential is comparable to the offering yield effects documented for municipal bonds following Moody's 2010 ratings recalibration (Adelino, Cunha, and Ferreira, 2017). While those rating-driven yield changes reflect alignment with global rating standards, our fragility-driven increases arise from the composition of the investor base, a factor entirely outside the issuer's control.

Thus, the fragility risk associated with mutual fund ownership in the secondary market spills over to the primary market. Shift-share instrumental variable estimates corroborate this finding (see Section 5.6 for details). We emphasize three caveats regarding the causal interpretation of the \$1.2–2.5 billion estimate. First, issuer-level fund beta is not randomly assigned: issuers whose outstanding bonds happen to be held by high-beta funds may differ in unobservable ways (such as the breadth of their investor base, the frequency of issuance, or institutional quality) that independently affect offering yields. Our county-by-month fixed effects absorb regional and temporal variation but cannot fully rule out issuer-level selection. Second, the upper bound (\$2.5 billion) assumes the *entire* 14 bps differential is causally attributable to fund fragility, while the lower bound (\$1.2 billion) assumes half is causal, with no empirical basis for either fraction. The true causal share likely lies within this range but remains uncertain. Third, the calculation assumes a constant flow-price relationship across the yield distribution, whereas in practice, the marginal impact of fragile ownership may vary with bond characteristics. Despite these limitations, the estimates provide a useful order-of-magnitude benchmark for the aggregate cost of ownership-driven fragility in the municipal bond market.

6.2 Quantity rationing

If municipalities exposed to high-beta funds face higher costs, they may be forced to reduce borrowing. Table 10 examines the *amount* of financing. We aggregate all issues to the county–year level. The sample includes all county–years between 2007 and 2021, including those with zero issuance activity, provided the county has at least one outstanding bond held by muni funds as of the previous year. This condition is necessary to construct *fund beta*.

Within a state and in a given year, a one–standard-deviation increase in county-level fund beta is associated with nearly \$34 less issuance per capita, corresponding to about 4% of the sample standard deviation. The coefficient on *direct fund beta* is significant, while the coefficient on *indirect fund beta* is large but not statistically significant. In columns 3–4, results are similar when scaling the county's issuance amount by its GDP as of the previous year. The (untabulated) results in the weighted least squares regressions are also similar, where the weights are based on the county's population or GDP from the previous year.

As county-level aggregate measures are noisy and do not account for bond-level heterogeneity, we interpret these findings with caution. Nonetheless, Table 10 provides suggestive evidence of a market distortion that may reduce public investment and spending. The implied quantity rationing may force local governments to delay infrastructure projects or cut spending during aggregate downturns. Substitution to alternative financing sources, such as bank financing, is frictional and limited (Dagostino, 2025), meaning that a contraction in the bond market likely translates into a net reduction in available capital for public goods.

6.3 Welfare implications and policy

Is the Fragility Tax efficient? One may argue that the answer is yes. If high-beta funds face real liquidation risk, the yield premium is just the market pricing that risk correctly. Bonds with different ownership structures face different effective liquidation costs, and the yield spread compensates investors accordingly.

While part of the yield differential may indeed reflect rational compensation, several features of our evidence are difficult to reconcile with a pure efficiency interpretation. Two bonds from the same municipality, with the same credit rating and cash flows, trade at different yields because of who holds them. The issuer has no say in, and typically no knowledge of, which funds hold its bonds in the secondary market, yet it bears the cost. Cash buffers attenuate the effect. If the premium compensated for bond-level risk, the liquidity position of the holder should be irrelevant. The effect is amplified when holding funds belong to fund families with larger equity fund shares (Table 6). The fund family's asset mix is a feature of the intermediary, not the bond. And the effect is substantially larger during stress (34.7 bps) than in calm markets (2.4 bps). This pattern is more consistent with time-varying fire-sale risk than with compensation for a fixed unobservable.

6.3.1 Decomposing the social cost

The social cost of the Fragility Tax has three components. The first is a *transfer*: municipalities pay higher yields to compensate investors for bearing ownership-driven fire-sale risk, and this cost falls on local taxpayers through higher taxes, reduced services, or deferred maintenance. If this were the entire story, the friction would be distributive but not necessarily inefficient. Investors would bear a real risk and be compensated accordingly. Our estimate of \$1.2–2.5 billion annually in excess financing costs (Section 6.1) measures this transfer.

The second component is an *allocative distortion*: higher borrowing costs reduce municipal investment. Counties whose outstanding bonds are held by high-beta funds issue significantly less debt, approximately \$34 less per capita for a one-standard-deviation increase in fund beta (Table 10). If the marginal infrastructure project has positive social returns (and the public finance literature generally finds that it does (Adelino, Cunha, and Ferreira, 2017)), then the forgone investment represents a deadweight loss rather than a pure transfer. The Fragility Tax drives a wedge between the municipality's effective borrowing rate and the rate that would prevail absent the intermediary friction, causing projects that pass the social cost-benefit test to fail the market test. Because substitution to alternative financing sources is frictional and limited (Dagostino, 2025), the bond market contraction likely translates into a net reduction in public capital formation.

The third component is *cyclical amplification*. The Fragility Tax peaks during stress periods (34.7 bps during high-VIX versus 2.4 bps during low-VIX; Table 6), when the social return to counter-cyclical public spending is highest. The friction thus generates pro-cyclical fiscal austerity (municipalities borrow less exactly when they should borrow more), amplifying the real effects of financial downturns on local public goods provision. The retail liability base of open-end funds is *fickle capital* in the sense of Caballero and Simsek (2020). That is, capital that is stable in good times but flees during stress, destabilizing asset markets during downturns. In their framework, fickle capital generates excessive volatility because its exit tightens financial conditions pro-cyclically. Our evidence extends this mechanism from financial markets to public finance. The flight of retail capital from muni funds during equity downturns raises the cost of local public goods provision when communities are under the most fiscal stress.

6.3.2 The pecuniary externality

The core market failure is a pecuniary externality of the type formalized in Lorenzoni (2008). When a fund shareholder redeems, she does not internalize two costs imposed on third parties. Redemption-driven forced sales depress the market price of bonds held by remaining fund investors, diluting their wealth. More importantly, the fire-sale price impact widens yield spreads on the issuer's outstanding debt and, through primary market spillovers (Table 9), raises the municipality's future borrowing costs. Because municipalities and their taxpayers are not parties to the fund contract, they bear a cost they cannot prevent, hedge, or influence. In standard models of fund fragility, the costs of runs fall primarily on fund investors. In our setting, the externality crosses the boundary between financial intermediation and public finance: household portfolio decisions in one market determine the cost of capital for local governments in another.

This externality goes beyond redistribution. In the framework of Lorenzoni (2008), pecuniary externalities generate *constrained inefficiency* (welfare losses that a social planner subject to the same market structure would choose to avoid) when fire-sale price changes tighten the financial constraints of other agents. This condition is satisfied in our setting. Municipalities face a binding borrowing constraint. They can issue debt only at prevailing market yields, and those yields are set in secondary markets where the Fragility Tax operates. When redemption-driven selling widens yield spreads, the municipality's effective borrowing rate rises, tightening its budget constraint and reducing feasible public investment. The quantity rationing we document in Table 10 is direct evidence that the price externality constrains real decisions. A social planner who could coordinate redemption behavior would leave the same bonds with the same holders but eliminate the fire-sale discount embedded in yields, lowering borrowing costs without altering any fundamental.

Competitive markets cannot self-correct this externality because no agent has the incentive to internalize it. Redeeming investors optimize their own liquidity needs; fund managers cannot restrict redemptions beyond contractual limits; and municipalities cannot choose or influence their secondary-market investor base. The daily redemption right (a contractual feature that each investor treats as individually costless) generates collective fragility because its cross-market consequences are not priced into the contract. The mechanism is analogous to the contractual externality in Ozdenoren and Yuan (2017). Individually rational contract terms produce socially excessive risk, and the equilibrium features more fragility than is socially optimal. Each fund sponsor offers daily redemption because investors demand it and competitors offer it; the resulting market structure produces a fragility externality that no individual sponsor has the incentive to correct.

6.3.3 Policy instruments

Two classes of policy instruments can address the externality, operating through distinct channels.[30]

The first is *quantity regulation*: mandatory cash buffer requirements that reduce the probability of fire sales. The SEC's Liquidity Risk Management Rule (Rule 22e-4), adopted in 2016, requires funds to classify holdings by liquidity and maintain minimum liquid asset

[30] Korinek and Simsek (2016) show in a complementary setting that fire-sale externalities compound aggregate demand externalities during deleveraging, reinforcing the case for ex ante macroprudential intervention.

thresholds. Our results provide empirical support for such regulations. Table 6 shows that higher cash-to-assets ratios substantially attenuate the Fragility Tax. Cash buffers work by weakening the causal chain from redemption to forced liquidation to price impact. They reduce the underlying fragility by increasing the probability that outflows can be met without selling illiquid bonds. A useful precedent for the feasibility of contractual-structure regulation in this market comes from money market funds. As shown in Figure IA1, the muni-holdings share of money market funds fell from 12% in 2008 to 3% by 2021 in response to the SEC's 2014 and 2016 reforms imposing floating NAV and discretionary gates on prime and tax-exempt funds. The episode demonstrates that targeted regulation of fund liability structure can reshape the institutional composition of muni intermediation within a few years.

The second is *Pigouvian correction*: swing pricing, which adjusts NAV so that redeeming investors (not remaining shareholders or third-party municipalities) bear the liquidation cost of their own redemptions. Swing pricing modifies the contract terms that generate the externality, so that individual exercise of the redemption option reflects its social cost. While cash buffers reduce the probability of the externality-generating event, swing pricing directly reduces the incentive to redeem in the first place by eliminating the first-mover advantage that makes runs self-fulfilling (Jin et al., 2022). The two instruments are complements rather than substitutes. A fund with both adequate cash reserves and swing pricing would transmit substantially less fire-sale risk to bond prices than a fund with neither.[31]

We can quantify the potential savings from higher cash buffers. The interaction coefficient between fund beta and cash in Table 6 implies that a one-standard-deviation increase in the holding funds' cash-to-assets ratio reduces the Fragility Tax by approximately 2.2 bps per standard deviation of fund beta. Applied to secondary market pricing, this translates to the following counterfactual estimates. If all funds currently holding below-median cash reserves increased their cash holdings by one standard deviation, the implied reduction in secondary-market pricing distortion would be approximately \$287 million per year, based on the \$2 trillion in aggregate trading volume attributable to these bonds.[32] Under more

[31] A third instrument (gates or redemption suspensions) restricts the exercise of the redemption option. While effective in severe crises, gates create their own externalities by triggering pre-emptive runs (investors redeem early to avoid being locked in), as documented during the 2016 U.K. property fund suspensions. We therefore focus on cash buffers and swing pricing, which operate through prices rather than quantities.

[32] This calculation applies the interaction coefficient (-2.16 bps) to the subsample's aggregate trading volume, using the full-sample standard deviation (sd) of cash. 1 sd of cash within the below-median subsample is

conservative assumptions (restricting to funds in the bottom quartile of cash holdings), the estimate is \$129 million per year. Focusing on stress periods, when the Fragility Tax is largest, the savings during above-median VIX periods would be approximately \$302 million per year. Even under the most conservative scenario, these estimates represent 10–25% of the total Fragility Tax, suggesting that feasible liquidity regulation can substantially reduce the friction. We note that these estimates capture the effect of cash buffers alone; the additional attenuation from swing pricing (which our data do not permit us to quantify directly) would further reduce the externality by discouraging the redemptions themselves.

Beyond the financing cost transfer, we can provide a rough lower bound on the *allocative* cost, the deadweight loss from forgone public investment. The quantity rationing estimate implies approximately \$34 less issuance per capita for a one-standard-deviation increase in county-level fund beta (Table 10, column 1). Our unbalanced sample covers over 2,100 unique counties; applying the point estimate to the counties with above-median fund beta exposure and weighting by population suggests forgone issuance on the order of \$4 billion annually.[33] If the social return on the marginal municipal infrastructure project exceeds the borrowing cost (as the public finance literature generally suggests (Adelino, Cunha, and Ferreira, 2017)), the welfare loss from this underinvestment exceeds the financing cost transfer. The deadweight loss is concentrated during stress periods, when the Fragility Tax is largest and the social return to counter-cyclical public spending is highest. We note that this estimate is speculative and subject to the causal interpretation caveats discussed earlier.[34]

7 Robustness

Table IA19 reports robustness to alternative specifications, weighting, dependent variables, controls, and subsamples; the fund-beta coefficient remains highly significant in all cases.

smaller than the full-sample sd, so the implied increase may be ambitious for the most cash-constrained funds. Also, the secondary market pricing distortion represents an upper bound for primary market borrowing cost savings, since the spillover from secondary to primary markets is likely attenuated.

[33] This calculation is illustrative. It applies the point estimate from column 1 of Table 10 to the affected population, assuming the estimate is causal. The true causal effect may be smaller, and some forgone bond market borrowing may be partially offset by alternative financing sources. We use the county-level population from the Bureau of Economic Analysis as of the year preceding each observation.

[34] A full welfare analysis would require jointly modeling municipal investment decisions, the general equilibrium effects of tighter liquidity requirements on fund availability and investor access, and the optimal mix of quantity regulation and Pigouvian correction, which we leave for future work.

Identifying the issuer using Mergent's *issuer_long_name* instead of the 6-character CUSIP (specification 2), restricting fixed effects to rating and date (specification 3, where coefficients are larger, consistent with issuer-date FE absorbing part of the wedge), and adding dealer-date FE on the 2007–2017 subsample (specification 4) all leave the result intact.

Specification (5) includes bond, rating, and date fixed effects. The coefficient on *fund beta* decreases by two-thirds to 7.90, and the coefficient on *direct fund beta* declines proportionally. Examining this attenuation clarifies the mechanism.

The 25 bps baseline estimate captures the *total* Fragility Tax, which reflects two distinct sources of variation. The first is *cross-sectional sorting*: bonds with certain persistent characteristics (lower liquidity, longer maturity, smaller issue size) are held disproportionately by high-beta funds, and these bonds trade at persistently higher yields. Bond fixed effects absorb this variation entirely. The second is *within-bond dynamic ownership changes*: when the same bond's ownership shifts toward higher-beta funds over time, its yield spread widens. The 8 bps estimate captures only this second component.

We argue that 8 bps is best interpreted as an *extreme lower bound* on the Fragility Tax, not as the "true" effect. Bond fixed effects remove all persistent cross-sectional variation in fund beta, but much of that variation *is* the Fragility Tax. It reflects the equilibrium sorting of bonds into fragile versus stable ownership. Absorbing it does not eliminate the friction; it removes most of the identifying variation. Conversely, the 25 bps baseline may include some residual bond-level heterogeneity not captured by our controls, making it an *upper bound*. The matched-sample estimate of 14 bps (Section 5.4), which non-parametrically absorbs all observable bond characteristics while preserving cross-sectional variation, provides our preferred conservative estimate. The true effect likely lies between 14 and 25 bps. The active turnover decomposition in Table IA13 helps bridge the gap: *active* shifts toward high-beta funds predict yield widening ($t = 11.07$), confirming that the within-bond effect is causal and directional. That is, ownership drives prices, not the reverse. The smaller magnitude is expected, since within-bond variation in fund beta is modest relative to cross-sectional variation. The other identification tests (discussed in Section 5) further support the causal interpretation of the larger baseline estimate.

Measurement and estimation. The result is robust to weighting by the across-fund R^2 or $|t|$ from the beta-estimation regression in Equation 1 (specifications 6–7), by mutual fund holdings (specification 8), to Dimson (Dimson, 1979) betas that add three lagged market returns (specification 9, where the smaller total-beta coefficient is driven by the indirect component; direct beta is unchanged, confirming that stale pricing does not affect core findings), and to using trading yield or non-tax-adjusted yield spread as the dependent variable (specifications 10–11).

Specification (12) controls for the bond's Amihud, measured over the previous month. Specifications (13)–(14) address the concern that fund beta may proxy for fund performance or flow pressure, the channels through which the capital-supply effect of Adelino et al. (2026) operates. We control for the holding funds' 12-month average return (specification 13) and additionally for the bond's flow pressure (specification 14). The coefficients on fund beta remain very similar to the baseline, indicating that the Fragility Tax operates independently of the capital-supply channel. As established in Section 2.1, fund beta and fund return are essentially uncorrelated, confirming these capture distinct aspects of fund characteristics. Table IA20 examines this distinction by interacting fund beta with fund return and fund ownership. The interaction between fund beta and fund return is negative and statistically significant (-1.97, $t = -5.62$): the Fragility Tax is amplified when holding funds have performed poorly, since poor performance generates outflows that deplete cash buffers and increase fire-sale pressure. The level effect of fund beta remains large and significant (26.95, $t = 12.50$) after including the interaction, confirming that the Fragility Tax operates independently of performance-driven capital flows. The interaction between fund beta and mutual fund ownership is positive and significant (2.43, $t = 4.42$): the effect is stronger when funds hold a larger share of the bond, as predicted by the flow-based mechanism.

Subsample analysis. Specifications (15)–(20) split the sample based on whether the trade is small or large (using a $100,000 par amount cutoff), on mutual fund ownership, and on aggregate net outflows.[35] The results remain consistent in all subsamples. The effect is *stronger* when mutual fund ownership is higher (specifications 17–18). The cross-market interpretation is reinforced by the joint pattern of two market-condition splits. VIX, a proxy for equity-market stress, amplifies the effect across both baseline and bond-fixed-effect specifications (Table IA22). Aggregate muni fund flows, a proxy for muni-specific conditions, do not produce a consistent amplification pattern. The friction is driven by equity-side rather

[35] We split by size to confirm the Fragility Tax holds across both small and large trades, not to classify retail versus institutional investors. Hund et al. (2026) document that the conventional $100,000 threshold performs poorly as such a classification; we rely on share-class composition for retail/institutional inference.

than muni-side variation, consistent with cross-market transmission.

Finally, specifications (22)–(23) show that the main effects exist excluding the COVID-19 period (2020H1) and are even stronger in the subsample with non-missing bond beta. Tables IA21 and IA22 further examine variation across bond characteristics and market conditions. The effect is stronger for less liquid or riskier bonds (lower credit ratings, longer maturities), consistent with the fire-sale mechanism, and intensifies during high-VIX periods.

8 Conclusion

Open-end municipal bond funds promise daily liquidity on assets that do not trade daily. We document the cost of that promise. Bonds held by funds with high equity-market sensitivity trade at yield spreads 14 to 25 bps higher than bonds from the same issuer held by stable funds. The bonds are no riskier; the holders are fragile. We call this pricing wedge the Fragility Tax.

Our proposed mechanism works as follows. When equity markets decline, retail investors liquidate across their portfolios, a dash for cash driven by wealth effects, borrowing constraints, and, during severe stress, indiscriminate flight from non-cash assets. The open-end fund's daily redemption right enables this cross-market transmission, forcing managers to liquidate illiquid bonds at steep discounts. Markets anticipate this, embedding expected fire-sale costs into yields even before any selling occurs. The decomposition into direct and indirect fund beta pins down the channel. We find that only direct equity sensitivity matters, which rules out the possibility that fund beta proxies for equity-correlated bond risk. We show that cash buffers attenuate the effect, while retail share, fund family equity orientation, extrapolative expectations, and household pessimism amplify it beyond what rational liquidity needs alone would predict. Closed-end funds, which share the same retail client base but lack the redeemable liability structure, exhibit less than half the pricing impact, isolating the flow channel from sentiment alone. Matched-sample estimation, a Puerto Rico quasi-experiment, and shift-share instrumental variables all confirm the causal interpretation, with IV estimates exceeding OLS across both secondary and primary market specifications.

The consequences extend beyond secondary markets. Municipalities whose outstanding bonds are held by high-beta funds face higher borrowing costs and issue less debt. The friction raises aggregate municipal borrowing costs by up to $2.5 billion annually (1.5% of muni debt service) and reduces local public investment by an estimated $4 billion in forgone issuance. This quantity rationing likely translates into deferred infrastructure and pro-cyclical fiscal austerity. The friction persists because muni bonds are nearly impossible to arbitrage. OTC transaction costs, extreme fragmentation across a million CUSIPs, tax clientele segmentation, and the absence of short-selling prevent arbitrage activity from reducing the yield wedge.

The Fragility Tax goes beyond mispricing. It is a pecuniary and contractual externality, generating constrained inefficiency. When investor A redeems, the cost falls on investor B, on the municipality, and on taxpayers who are not parties to the fund contract. No agent in the system has the incentive to internalize this cost. Cash buffer requirements (of the type mandated by SEC Rule 22e-4) offer a direct policy lever, and our results suggest they work. Higher cash holdings substantially weaken the link between fund fragility and bond pricing, with counterfactual estimates suggesting that feasible increases in fund cash reserves could reduce the aggregate Fragility Tax by 10–25%. Swing pricing offers a complementary instrument by internalizing the cost of redemption at the point of exercise.

Finally, there is no reason this problem is confined to municipal bonds. The same contractual mismatch (liquid liabilities funding illiquid assets) exists wherever open-end vehicles have grown to intermediate markets they were not designed for. The March 2020 dislocations in corporate bond ETFs and the 2016 suspensions of U.K. property funds are reminders.[36] Our results establish that the identity of the holder affects the price of the asset. The relevant dimension of identity is the contractual terms under which capital can leave.

[36] In March 2020, corporate bond ETFs traded at discounts exceeding 5% to net asset value as redemption pressure overwhelmed the liquidity of the underlying bond portfolios, prompting Federal Reserve intervention through the Secondary Market Corporate Credit Facility. In July 2016, six major U.K. open-end property funds suspended redemptions within two weeks of the Brexit referendum, freezing approximately £14.5 billion in investor capital.

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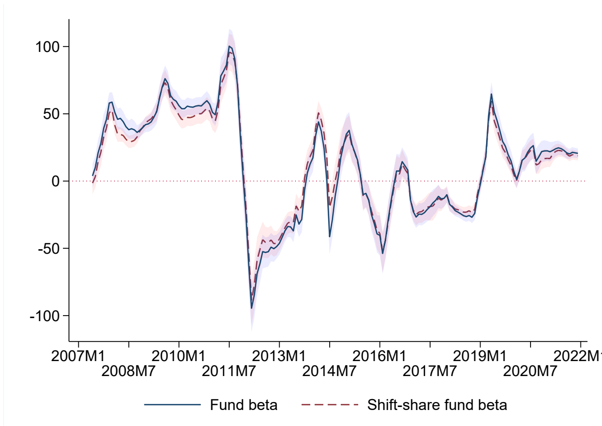
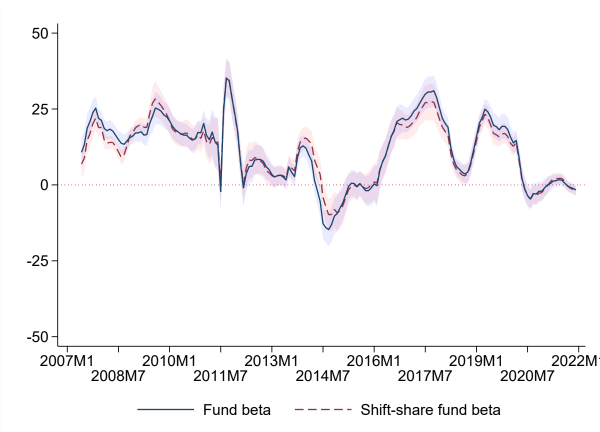
Figure 1
The Fragility Tax over time

This figure plots the estimated coefficients, along with their 95% confidence intervals, from the six-month rolling regressions of tax-adjusted yield spread on bond-level average monthly fund beta as of the previous month, following the specifications in column 1 of Table 2 and column 3 of Table 3. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. The dashed line plots the estimated coefficients using shift-share *Fund beta*, which is estimated based on fund-level beta as of month $m-1$ and fund holdings as of month $m-13$.

(a) Fund beta



(b) Direct fund beta



(c) Indirect fund beta

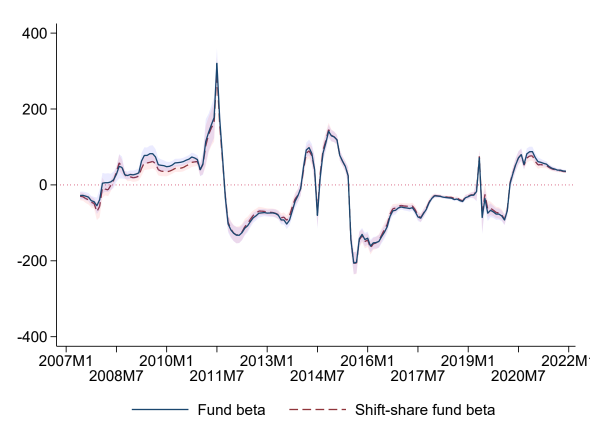
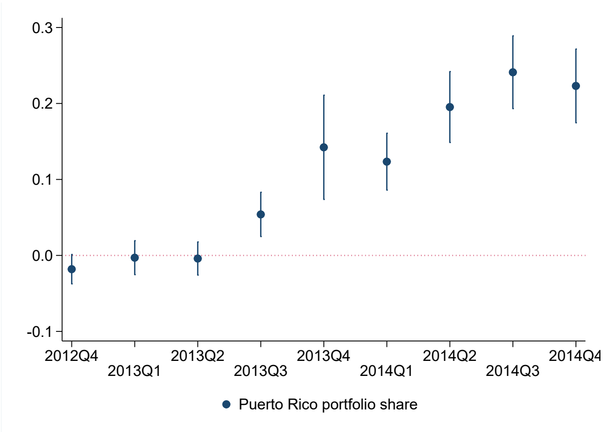


Figure 2
Fund beta, fund outflows, and Puerto Rico exposure: Fund level

This figure plots the sensitivity, along with its 95% confidence intervals, of fund beta and fund net outflows to the fund's Puerto Rico portfolio share, measured as of 2012Q3, between 2012Q4 and 2014Q4. Regression results are reported in Internet Appendix Table IA15. Fund beta and Puerto Rico portfolio share are standardized to have a mean of zero and a standard deviation of one. Monthly net outflows are in percentage points. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund.

(a) Fund beta (standardized)



(b) Net outflows (%)

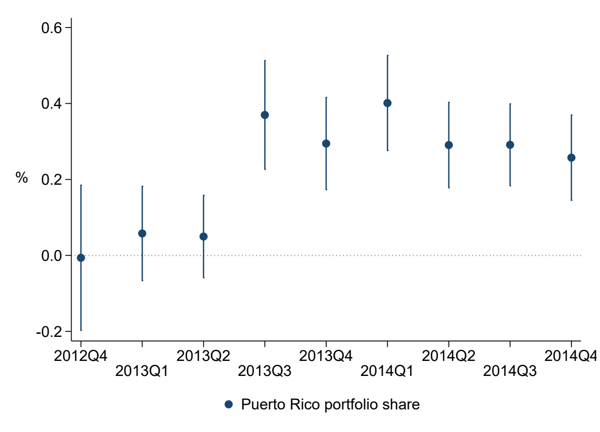


Figure 3
Yield spread and Puerto Rico exposure: Trade level

This figure plots the sensitivity, along with its 95% confidence intervals, of tax-adjusted yield spread to Puerto Rico exposure, measured as of 2012Q3, between 2012Q4 and 2014Q4. Regression results are reported in Internet Appendix Table IA15. *Puerto Rico exposure* is the bond's par amount held by open-end muni funds, adjusted for the holding funds' portfolio share of Puerto Rico bonds (Equation 9 in Section 5.5). Puerto Rico exposure is standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day.

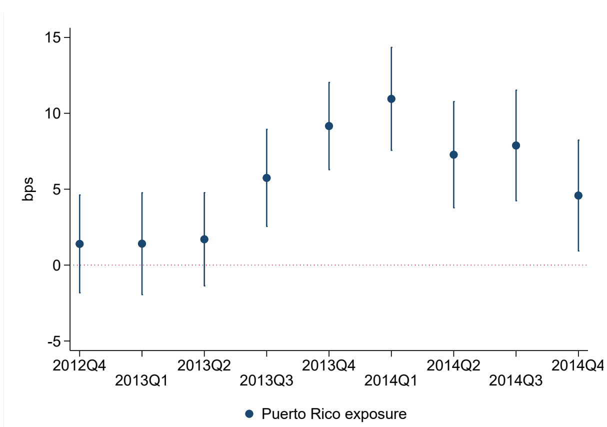


Table 1
Summary statistics

This table reports summary statistics for the sample of municipal bond trades between 2007 and 2021. Bonds are required to be tax-exempt and either fixed-rate or zero-coupon. Variable definitions are in Table IA1. Bond ratings are encoded so that AAA = 0, AA+ = 1, ..., BB+ = 10, ..., C = 20. The unit of observation is a transaction.

				Percentile		
	N	Mean	SD	25th	50th	75th
Explanatory variables						
Fund beta	18,012,021	0.01	0.09	-0.05	-0.00	0.06
Direct fund beta	18,012,021	0.01	0.03	-0.00	0.01	0.02
Indirect fund beta	18,012,021	-0.00	0.07	-0.06	-0.01	0.05
Fund muni beta	18,012,021	0.97	0.31	0.84	0.98	1.13
Bond beta	10,109,187	0.01	0.18	-0.08	0.01	0.10
Bond muni beta	10,109,187	0.90	0.74	0.34	0.83	1.34
Aggregate muni beta	18,012,021	-0.01	0.07	-0.07	-0.01	0.05
Bond characteristics						
Yield (bps)	18,012,021	305.64	173.59	159.20	290.00	449.90
Yield spread, not tax-adjusted (bps)	18,012,021	44.04	124.70	-32.35	30.05	106.24
Yield spread (bps)	18,012,021	255.70	222.61	87.80	228.35	398.05
Bond sale	18,012,021	0.36	0.48	0.00	0.00	1.00
Par traded ($m)	18,012,021	0.23	1.87	0.01	0.03	0.07
Mutual fund holding (%)	18,012,021	29.98	26.72	10.20	23.77	42.70
# holding funds	18,012,021	3.83	5.61	1.00	2.00	4.00
Flow pressure	17,989,520	-0.12	8.35	-0.31	-0.06	0.06
Cash (%)	18,011,039	1.03	1.74	0.00	0.44	1.29
Family's equity fund share	18,012,006	0.56	0.14	0.48	0.58	0.67
Retail share	18,005,114	0.81	0.26	0.73	0.93	1.00
Offering amount ($m)	18,012,021	89.18	235.80	15.27	37.26	87.78
Callable bond	18,012,021	0.75	0.43	0.00	1.00	1.00
General obligation bond	18,012,021	0.21	0.41	0.00	0.00	0.00
Insured bond	18,012,021	0.26	0.44	0.00	0.00	1.00
Credit-enhanced bond	18,012,021	0.04	0.21	0.00	0.00	0.00
Bank-qualified bond	18,012,021	0.00	0.05	0.00	0.00	0.00
Bond age (years)	18,012,021	4.92	3.93	1.91	4.18	7.02
Bond maturity (years)	18,012,021	15.39	9.32	7.21	15.18	22.99
Bond turnover (%)	18,012,021	4.86	11.69	0.12	0.73	3.11
Bond rating	16,898,097	3.60	2.58	2.00	3.00	5.00
Market conditions						
Sentiment	18,012,021	81.45	12.45	72.30	81.20	93.40
DOX	14,157,413	0.47	0.20	0.29	0.48	0.60
Market markup (%)	18,012,021	0.88	0.30	0.64	0.85	1.09
VIX	18,012,021	20.75	10.67	13.90	17.58	23.47
Aggregate net outflows (%)	16,028,212	-0.01	0.08	-0.05	-0.02	0.01

Table 2
Yield spread and fund beta

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. *Bond beta* (*bond muni beta*) is estimated using a 24-month rolling regression of the bond's monthly excess return on the excess stock (muni) market return, requiring a minimum of 12 observations. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)
Fund $\text{beta}_{b,m-1}$	25.338***				17.869***
	(2.082)				(2.355)
Fund muni $\text{beta}_{b,m-1}$		28.423***			21.893***
		(0.952)			(1.015)
Bond $\text{beta}_{b,m-1}$			1.571*		2.460***
			(0.832)		(0.705)
Bond muni $\text{beta}_{b,m-1}$				41.668***	39.276***
				(1.070)	(1.001)
Ln(Par $\text{traded})_{b,t}$	−12.464***	−12.311***	−14.962***	−14.466***	−14.275***
	(0.221)	(0.216)	(0.323)	(0.308)	(0.302)
Mutual fund $\text{holding}_{b,m-1}$	6.682***	6.155***	6.683***	6.085***	5.267***
	(0.619)	(0.603)	(1.121)	(0.945)	(0.902)
Ln(Offering $\text{amount})_{b}$	−1.174	−1.085	−2.608	−3.643**	−4.571***
	(0.914)	(0.904)	(1.655)	(1.475)	(1.432)
Callable bond_{b}	−20.058***	−26.029***	−30.239***	−15.018***	−18.822***
	(1.944)	(1.895)	(2.932)	(2.296)	(2.244)
General obligation bond_{b}	1.717	5.440	−4.291	2.767	3.461
	(4.965)	(4.996)	(7.397)	(6.146)	(5.831)
Insured bond_{b}	12.178***	9.950***	22.019***	15.670***	13.804***
	(2.651)	(2.564)	(4.016)	(3.528)	(3.416)
Credit-enhanced bond_{b}	−6.447	−5.829	−14.765	−15.310	−14.179
	(7.200)	(6.977)	(12.699)	(12.024)	(11.742)
Bank-qualified bond_{b}	13.335	12.204	38.878***	49.159***	51.663***
	(13.159)	(12.690)	(12.653)	(12.468)	(12.548)
Ln(Bond $\text{age})_{b,t}$	−39.107***	−40.004***	−58.850***	−42.942***	−43.838***
	(0.870)	(0.860)	(2.173)	(1.965)	(1.921)
Ln(Bond $\text{maturity})_{b,t}$	28.020***	13.762***	24.316***	5.801***	−4.659***
	(1.069)	(1.117)	(1.478)	(1.306)	(1.404)
Bond $\text{turnover}_{b,m-1}$	1.458***	1.107***	1.592***	0.344	0.018
	(0.241)	(0.241)	(0.496)	(0.451)	(0.448)
N	18,012,021	18,012,021	9,851,113	9,851,113	9,851,113
Adjusted R^2	0.77	0.78	0.77	0.78	0.79
Issuer×Date FEs	✓	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓

Table 3
Yield spread and fund beta components

This table reports results of regressions of a bond's tax-adjusted yield spread on the components of fund beta:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta components}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. *Fund beta* is decomposed into: 1) *Direct fund beta*, the coefficient β_1 on *Excess stock market return* from Equation 3 in Section 2.1, and 2) *Indirect fund beta*, the remaining component. *Indirect fund beta* is further expressed as the product of: 3) *Fund muni beta*, the coefficient β_2 on *Excess muni market return* in Equation 3, and 4) *Aggregate muni beta*, the sensitivity of the excess muni market return to the excess stock market return. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)
Direct fund beta$_{b,m-1}$	16.964***		17.213***		
	(0.987)		(0.947)		
Indirect fund beta$_{b,m-1}$		2.824	−4.603**		
		(2.484)	(2.005)		
Fund muni beta$_{b,m-1}$				28.423***	
				(0.952)	
Aggregate muni beta$_{m-1}$					−13.670***
					(2.539)
Ln(Par traded)$_{b,t}$	−12.429***	−12.532***	−12.429***	−12.311***	−14.285***
	(0.220)	(0.221)	(0.220)	(0.216)	(0.229)
Mutual fund holding$_{b,m-1}$	6.657***	7.054***	6.685***	6.155***	7.788***
	(0.612)	(0.631)	(0.612)	(0.603)	(0.569)
Ln(Offering amount)$_b$	−1.535*	−0.432	−1.526*	−1.085	−0.433
	(0.910)	(0.931)	(0.911)	(0.904)	(0.887)
Callable bond$_b$	−20.351***	−20.311***	−20.415***	−26.029***	−20.606***
	(1.938)	(1.939)	(1.937)	(1.895)	(1.786)
General obligation bond$_b$	2.371	2.868	2.562	5.440	1.374
	(4.997)	(5.171)	(5.011)	(4.996)	(5.101)
Insured bond$_b$	12.558***	12.354***	12.628***	9.950***	9.457***
	(2.639)	(2.676)	(2.636)	(2.564)	(2.436)
Credit-enhanced bond$_b$	−6.771	−6.843	−6.851	−5.829	−3.283
	(7.195)	(7.204)	(7.194)	(6.977)	(6.162)
Bank-qualified bond$_b$	12.906	13.852	12.887	12.204	7.837
	(13.073)	(13.164)	(13.059)	(12.690)	(10.285)
Ln(Bond age)$_{b,t}$	−39.084***	−39.116***	−39.081***	−40.004***	−39.188***
	(0.867)	(0.878)	(0.867)	(0.860)	(0.823)
Ln(Bond maturity)$_{b,t}$	27.065***	28.563***	26.972***	13.762***	27.708***
	(1.056)	(1.075)	(1.056)	(1.117)	(0.992)
Bond turnover$_{b,m-1}$	1.355***	1.630***	1.354***	1.107***	1.273***
	(0.241)	(0.242)	(0.241)	(0.241)	(0.230)
N	18,012,021	18,012,021	18,012,021	18,012,021	18,012,021
Adjusted R^2	0.77	0.77	0.77	0.78	0.70
Issuer×Date FEs	✓	✓	✓	✓	
Issuer×Year-quarter FEs					✓
Rating FEs	✓	✓	✓	✓	✓

Table 4
Fund beta and net outflows

This table reports results of regressions of a fund's net outflows on its beta:

$$\textit{Net outflows (\%)}_{f,m} = \alpha_m + \beta \times \textit{Fund beta}_{f,m-1} + \eta' \mathbf{X}_{f,m-1} + \varepsilon_{f,m},$$

where f indexes funds and m year-months. Fund-level beta is estimated from the 24-month rolling regression of the fund's monthly excess return on CRSP excess return, requiring at least 18 observations. For each fund, the expected fund net outflows, scaled by fund size, are forecast from the 24-month rolling regression of net outflows on lagged net outflows and lagged return. Unexpected net outflows are the difference between the realized and expected net outflows. Fund characteristics in Internet Appendix Table IA4 are included but omitted for brevity. All continuous explanatory variables, including fund betas but excluding fund flows and returns, are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Realized outflows (%)		Expected outflows (%)		Unexpected outflows (%)	
	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{f,m-1}$	0.129***	0.117***	0.075***	0.065**	0.060**	0.056**
	(0.024)	(0.024)	(0.028)	(0.029)	(0.025)	(0.025)
Fund muni beta$_{f,m-1}$		0.042***		0.035*		0.013
		(0.016)		(0.019)		(0.017)
Net outflows$_{f,m-1}$	0.313***	0.313***	0.340***	0.340***	−0.038***	−0.038***
	(0.008)	(0.008)	(0.009)	(0.009)	(0.007)	(0.007)
Net outflows$_{f,m-2}$	0.161***	0.161***	0.158***	0.158***	−0.002	−0.002
	(0.007)	(0.007)	(0.005)	(0.005)	(0.007)	(0.007)
Net outflows$_{f,m-3}$	0.126***	0.126***	0.130***	0.130***	−0.003	−0.003
	(0.006)	(0.006)	(0.004)	(0.004)	(0.006)	(0.006)
Fund return$_{f,m-1}$	−0.091***	−0.094***	−0.113***	−0.115***	0.025	0.024
	(0.016)	(0.016)	(0.019)	(0.019)	(0.018)	(0.018)
Fund return$_{f,m-2}$	−0.006	−0.007	0.050***	0.049***	−0.057***	−0.058***
	(0.016)	(0.016)	(0.009)	(0.009)	(0.017)	(0.017)
Fund return$_{f,m-3}$	0.006	0.004	0.057***	0.055***	−0.049***	−0.050***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.014)	(0.014)
N	93,345	93,345	93,345	93,345	93,345	93,345
Adjusted R^2	0.36	0.36	0.58	0.58	0.10	0.10
Dependent variable mean	−0.322	−0.322	−0.387	−0.387	0.068	0.068
Dependent variable SD	2.380	2.380	1.802	1.802	2.211	2.211
Fund controls	✓	✓	✓	✓	✓	✓
Year-month FEs	✓	✓	✓	✓	✓	✓

Table 5
Flow pressure

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with flow pressure measures:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Flow pressure}_{b,m} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. For each fund, the expected fund net outflows, scaled by fund size, are forecast from the 24-month rolling regression of net outflows on lagged net outflows and lagged return. Bond-level *Flow pressure* is the sum of the (expected) net outflows associated with all funds' positions in the bond, scaled by the bond's offering amount. Columns 1–3 use month-m realized flow pressure and columns 4–6 use month-m expected flow pressure. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	Realized flow pressure			Expected flow pressure		
	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{b,m-1}$		24.943***	25.914***		24.595***	25.535***
		(2.086)	(2.125)		(2.077)	(2.115)
Fund beta$_{b,m-1}\times$ Flow pressure$_{b,m}$		1.428***	1.157***		1.267***	0.816**
		(0.292)	(0.312)		(0.321)	(0.334)
Fund beta$_{b,m-1}\times$ Flow pressure$_{b,m}\times$ Sale$_{b,t}$			1.257***			1.462***
			(0.227)			(0.224)
Fund beta$_{b,m-1}\times$ Sale$_{b,t}$			−1.822***			−1.736***
			(0.377)			(0.379)
Flow pressure$_{b,m}\times$ Sale$_{b,t}$			3.172***			4.185***
			(0.278)			(0.234)
Flow pressure$_{b,m}$	3.776***	3.272***	2.342***	6.407***	5.681***	4.331***
	(0.307)	(0.288)	(0.331)	(0.371)	(0.344)	(0.368)
Sale$_{b,t}$			61.358***			61.399***
			(0.478)			(0.479)
N	17,987,982					
Adjusted R^2	0.77	0.77	0.79	0.77	0.77	0.79
Bond controls	✓	✓	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓

Table 6
Holding funds' cash buffer and fund families' share of equity funds

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with the holding funds' average cash-to-assets ratio or the holding fund families' average equity fund share:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Cash (or Equity fund share)}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. *Cash* is the par-weighted average cash-to-assets ratio across all open-end municipal bond funds holding the bond as of the previous month. *Family's equity fund share* is the par-weighted average family-level equity fund share across all open-end municipal bond funds holding the bond as of the previous month. Columns 3–4 split the sample based on the daily value of the Chicago Board Options Exchange's CBOE Volatility Index. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Panel A: Funds' average cash buffer				
			High VIX	Low VIX
	(1)	(2)	(3)	(5)
Fund beta$_{b,m-1}$	24.932***		34.705***	2.417
	(2.060)		(2.205)	(2.353)
Fund beta$_{b,m-1}\times$ Cash$_{b,m-1}$	−2.156***		−2.741***	−0.468
	(0.375)		(0.516)	(0.400)
Direct fund beta$_{b,m-1}$		16.987***		
		(0.932)		
Indirect fund beta$_{b,m-1}$		−5.231***		
		(1.980)		
Direct fund beta$_{b,m-1}\times$ Cash$_{b,m-1}$		−2.924***		
		(0.368)		
Indirect fund beta$_{b,m-1}\times$ Cash$_{b,m-1}$		−0.950***		
		(0.316)		
Cash$_{b,m-1}$	−1.250***	−1.821***	−0.522	−1.166***
	(0.321)	(0.323)	(0.393)	(0.364)
N	18,010,967	18,010,967	9,004,475	9,006,492
Adjusted R^2	0.77	0.77	0.79	0.75
Panel B: Fund families' average equity fund share				
			High VIX	Low VIX
	(1)	(2)	(3)	(4)
Fund beta$_{b,m-1}$	25.886***		36.109***	2.474
	(2.088)		(2.224)	(2.369)
Fund beta$_{b,m-1}\times$ Family's equity fund share$_{b,m-1}$	1.238***		2.126***	−0.566
	(0.399)		(0.535)	(0.361)
Direct fund beta$_{b,m-1}$		17.753***		
		(0.952)		
Indirect fund beta$_{b,m-1}$		−4.510**		
		(1.999)		
Direct fund beta$_{b,m-1}\times$ Family's equity fund share$_{b,m-1}$		1.730***		
		(0.469)		
Indirect fund beta$_{b,m-1}\times$ Family's equity fund share$_{b,m-1}$		0.689*		
		(0.364)		
Family's equity fund share$_{b,m-1}$	2.176***	2.774***	2.844***	0.418
	(0.444)	(0.458)	(0.510)	(0.477)
N	18,012,004	18,012,004	9,005,356	9,006,648
Adjusted R^2	0.77	0.77	0.79	0.75
Bond controls	✓	✓	✓	✓
Issuer$\times$Date FEs	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓

Table 7
Mutual fund trades versus other trades

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with the indicator for mutual fund trades:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Fund trade}_{b,t} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. *Fund trade* $= 1$ for trades by open-end municipal bond funds and 0 otherwise. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{b,m-1}$		25.238***	26.427***			
		(2.085)	(2.123)			
Fund beta$_{b,m-1}\times$ Fund trade$_{b,t}$		5.518***	3.719***		3.267***	−0.111
		(0.563)	(0.736)		(0.322)	(0.455)
Fund beta$_{b,m-1}\times$ Fund trade$_{b,t}\times$ Sale$_{b,t}$			1.822**			3.869***
			(0.765)			(0.540)
Fund beta$_{b,m-1}\times$ Sale$_{b,t}$			−2.309***			−0.976***
			(0.398)			(0.363)
Fund trade$_{b,t}\times$ Sale$_{b,t}$			−49.732***			−55.969***
			(0.833)			(0.723)
Fund trade$_{b,t}$	14.603***	15.080***	32.641***	6.687***	6.805***	26.171***
	(0.573)	(0.573)	(0.722)	(0.361)	(0.357)	(0.534)
Sale$_{b,t}$			62.526***			62.774***
			(0.498)			(0.518)
N	18,012,021	18,012,021	18,012,021	13,227,840	13,227,840	13,227,840
Adjusted R^2	0.77	0.77	0.79	0.93	0.93	0.94
Bond controls	✓	✓	✓			
Issuer×Date FEs	✓	✓	✓			
Bond×Date FEs				✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓

Table 8
Matched bond sample

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{group,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. For each trading day, we create quintiles of transactions based on the following characteristics: par traded, mutual fund holding, offering amount, bond age, bond maturity, and turnover. We then group transactions that occur on the same date, belong to the same quintile for each characteristic, and match in terms of bond rating, callability, general obligation/revenue classification, insurance, credit enhancement, and bank qualification. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)
Fund beta$_{b,m-1}$	26.918***		14.124***	
	(1.454)		(0.962)	
Direct fund beta$_{b,m-1}$		26.869***		10.086***
		(0.847)		(0.445)
Indirect fund beta$_{b,m-1}$		13.368***		−3.122**
		(1.459)		(1.220)
Ln(Par traded)$_{b,t}$	−16.474***	−16.908***	−6.326***	−6.327***
	(0.992)	(0.992)	(0.181)	(0.181)
Mutual fund holding$_{b,m-1}$	21.815***	20.866***	3.906***	3.811***
	(1.314)	(1.303)	(0.683)	(0.673)
Ln(Offering amount)$_b$	37.843***	36.006***	1.298	1.140
	(1.972)	(1.901)	(1.034)	(1.032)
Ln(Bond age)$_{b,t}$	−46.485***	−44.883***	−18.693***	−18.479***
	(1.791)	(1.712)	(0.708)	(0.705)
Ln(Bond maturity)$_{b,t}$	76.241***	75.155***	6.946***	6.656***
	(1.658)	(1.616)	(0.567)	(0.557)
Bond turnover$_{b,m-1}$	10.324***	9.829***	−0.532***	−0.558***
	(0.515)	(0.514)	(0.138)	(0.139)
N	17,907,825	17,907,825	17,888,513	17,888,513
Adjusted R^2	0.56	0.57	0.84	0.84
Matched group×Date FEs	✓	✓	✓	✓
Issuer×Date FEs			✓	✓

Table 9
Primary market issuance cost

This table reports results of regressions of a bond's offering yield spread on its issuer's fund beta:

$$\textit{Offering yield spread (bps)}_b = \alpha_{c,m} + \alpha_r + \beta \times \textit{Fund beta}_{i,m-1} + \eta' \mathbf{X}_b + \varepsilon_b,$$

where b indexes bonds, i issuers, c counties, r ratings, y years, and m year-months. Issuer-level *Fund beta* is the weighted average *fund beta* of the issuer's outstanding bonds as of the previous month, where the weight is determined by each bond's offering amount. The sample is limited to bond issues from issuers that have at least one outstanding bond held by open-end municipal bond funds as of the previous month. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a bond. Standard errors are adjusted for clustering by state and year-month. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Offering yield spread			Tax-adjusted offering yield spread		
	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{i,m-1}$	6.075***	8.095***		10.370***	13.695***	
	(0.853)	(1.228)		(1.422)	(2.057)	
Direct fund beta$_{i,m-1}$			4.060***			6.616***
			(0.535)			(0.928)
Indirect fund beta$_{i,m-1}$			1.505			3.448
			(1.457)			(2.489)
Mutual fund holding$_{i,m-1}$	2.607***	2.880***	2.735***	4.626***	5.202***	4.980***
	(0.438)	(0.514)	(0.503)	(0.789)	(0.868)	(0.852)
Negotiated sale$_b$	7.145***	5.918***	5.817***	11.816***	10.162***	10.007***
	(0.851)	(0.855)	(0.866)	(1.425)	(1.395)	(1.408)
Ln(Offering amount)$_b$	−4.140***	−3.205***	−3.174***	−7.948***	−6.462***	−6.415***
	(0.816)	(0.503)	(0.497)	(1.366)	(0.788)	(0.781)
Callable bond$_b$	22.046***	23.797***	23.791***	39.745***	42.466***	42.457***
	(2.258)	(1.685)	(1.693)	(3.180)	(2.289)	(2.301)
General obligation bond$_b$	−5.223*	−2.490	−2.310	−8.970*	−3.873	−3.598
	(2.674)	(3.249)	(3.251)	(4.480)	(5.361)	(5.373)
Insured bond$_b$	−0.031	0.754	0.745	−0.173	0.562	0.548
	(1.940)	(2.045)	(2.096)	(3.370)	(3.786)	(3.862)
Credit-enhanced bond$_b$	1.598	1.208	1.212	2.221	1.809	1.814
	(1.297)	(1.289)	(1.282)	(2.117)	(2.121)	(2.117)
Bank-qualified bond$_b$	−13.198***	−10.630***	−10.680***	−23.637***	−19.152***	−19.229***
	(1.523)	(1.941)	(1.897)	(2.421)	(3.020)	(2.955)
Ln(Maturity)$_b$	12.499***	11.563***	11.551***	61.239***	59.667***	59.648***
	(2.410)	(1.921)	(1.922)	(5.043)	(4.259)	(4.259)
Ln(GDP)$_{c,y-1}$	4.302			7.959		
	(4.752)			(7.875)		
Ln(Population)$_{c,y-1}$	−4.447			−8.233		
	(3.998)			(6.612)		
Ln(Average wage)$_{c,y-1}$	−0.262			−0.461		
	(1.782)			(3.089)		
Ln(House value)$_{c,y-1}$	0.822			1.198		
	(0.740)			(1.335)		
Unemployment rate$_{c,m-1}$	3.131***			5.349***		
	(0.505)			(0.895)		
Median age$_{c,y-1}$	0.338			0.354		
	(0.517)			(0.950)		
High school graduate$_{c,y-1}$	−0.527			−0.768		
	(0.328)			(0.597)		
N	709,838	709,838	709,838	709,838	709,838	709,838
Adjusted R^2	0.74	0.82	0.82	0.80	0.86	0.86
Dependent variable mean	31.831	31.831	31.831	205.144	205.144	205.144
Dependent variable SD	62.679	62.679	62.679	123.369	123.369	123.369
State×Year-month FEs	✓			✓		
County×Year-month FEs		✓	✓		✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓

Table 10
County-level issuance amount

This table reports results of regressions of a county's yearly issuance amount on its outstanding bonds' average fund beta:

$$\textit{Issuance amount}_{c,y} = \alpha_{s,y} + \beta \times \textit{Fund beta}_{c,y-1} + \eta'\mathbf{X}_{c,y} + \varepsilon_{c,y},$$

where c indexes counties, s states, and y years. County-level *Fund beta* is the weighted average *fund beta* of the county's outstanding bonds as of the previous year, where the weight is determined by each bond's offering amount. Yearly issuance amount is scaled by either the county's population or GDP, both measured from the previous year. The sample is limited to county-years that have at least one outstanding bond held by open-end municipal bond funds as of the previous year. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a county-year. Standard errors are adjusted for clustering by state. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Issuance amount per capita ($)		Issuance amount/GDP ($ per $1,000 GDP)	
	(1)	(2)	(3)	(4)
Fund beta$_{c,y-1}$	−33.644***		−0.817***	
	(9.952)		(0.244)	
Direct fund beta$_{c,y-1}$		−26.650***		−0.566***
		(6.439)		(0.152)
Indirect fund beta$_{c,y-1}$		24.919		0.263
		(17.735)		(0.376)
Mutual fund holding$_{c,y-1}$	33.468*	35.489**	0.641*	0.676**
	(16.905)	(16.811)	(0.320)	(0.318)
Ln(Outstanding debt)$_{c,y-1}$	686.540***	686.123***	13.413***	13.405***
	(82.153)	(82.202)	(1.529)	(1.529)
Ln(GDP)$_{c,y-1}$	245.448***	244.660***	−11.946***	−11.960***
	(69.389)	(69.321)	(1.241)	(1.242)
Ln(Population)$_{c,y-1}$	−758.997***	−758.640***	0.455	0.461
	(85.581)	(85.624)	(1.078)	(1.080)
Ln(Average wage)$_{c,y-1}$	55.479**	55.027**	0.208	0.200
	(26.162)	(26.121)	(0.321)	(0.321)
Ln(House value)$_{c,y-1}$	26.322	26.427	0.483	0.485
	(30.775)	(30.827)	(0.523)	(0.523)
Unemployment rate$_{c,y-1}$	−34.508*	−34.279*	−0.655*	−0.651*
	(18.685)	(18.572)	(0.330)	(0.331)
Median age$_{c,y-1}$	−7.689	−7.648	−0.506**	−0.506**
	(17.032)	(17.085)	(0.233)	(0.234)
High school graduate$_{c,y-1}$	−32.869	−32.648	0.575	0.579
	(30.286)	(30.233)	(0.385)	(0.383)
N	23,750	23,750	23,750	23,750
Adjusted R^2	0.25	0.25	0.18	0.18
Dependent variable mean	551.144	551.144	12.628	12.628
Dependent variable SD	900.307	900.307	18.466	18.466
State×Year FEs	✓	✓	✓	✓

Internet Appendix for

"The Fragility Tax: How Mutual Fund Ownership Links Segmented Markets"

This Internet Appendix provides supplementary results to complement the main findings in the paper.

1. Table IA1 provides definitions of variables used in the paper.
2. Figure IA1 plots the share of open-end mutual funds and other holders of U.S. municipal securities over time.
3. Figure IA2 illustrates the fund-beta decomposition.
4. Figure IA3 plots the time series of fund beta.
5. Figure IA4 shows the distribution of fund beta and its components.
6. Figure IA5 plots the average tax-adjusted yield spread of fund beta deciles.
7. Figure IA6 reports the weekly Google search interest in Puerto Rican government debt crisis in 2013 and 2014.
8. Figure IA7 reports the performance of Puerto Rico bonds between 2010 and 2017.
9. Figure IA8 reports the sensitivity of the weighted-average credit rating of non-Puerto Rico bonds in a fund's portfolio to the fund's exposure to Puerto Rico debt.
10. Table IA2 reports the correlation between fund beta and its components.
11. Table IA3 reports the baseline results on the subsamples of customer purchases and of customer sales.
12. Table IA4 reports the fund-level determinants of fund beta and its components.
13. Table IA5 reports the bond-level determinants of bond-level fund beta and its components.
14. Table IA6 demonstrates that fund-level net outflows are lower when market-level *Aggregate muni beta* is higher.
15. Table IA7 reports regression results of fund selling (buying) volume on fund beta and stock market volatility (VIX).
16. Table IA8 reports the role of retail investors in driving the Fragility Tax (retail share, consumer sentiment, and extrapolative beliefs).

17. Table IA9 reports regression results of share class net flows on lagged fund performance, interacting with an indicator for retail share classes.

18. Table IA10 exhibits that yield spread is more positively associated with *downside* direct fund beta than with *upside* direct fund beta; but is less positively associated with *downside* indirect fund beta than with *upside* indirect fund beta.

19. Table IA11 shows that the baseline results hold in the sample to the mutual fund trades and with fund-by-month fixed effects included.

20. Table IA12 shows that the effect of open-end fund beta is larger than that of closed-end fund beta.

21. Table IA13 shows that the "active" component of fund beta is positively associated with yield spreads.

22. Table IA14 examines whether fund beta proxies for bond fundamentals by exploiting portfolio heterogeneity.

23. Table IA15 reports results of regressions from Figures 2–3 regarding the bond's exposure to Puerto Rico debt crisis.

24. Tables IA16, IA17, and IA18 report shift-share instrumental variable results for secondary market yield spreads, primary market issuance costs, and county-level issuance amounts, respectively.

25. Table IA19 reports robustness of the baseline yield-spread results to alternative specifications, weighting, dependent variables, controls, and subsamples.

26. Table IA20 reports the interaction between fund beta and fund return/fund ownership. The negative interaction with fund return indicates that poor performance amplifies the Fragility Tax through increased outflow pressure, while the level effect of fund beta remains significant.

27. Table IA21 reports the results conditional on bond characteristics.

28. Table IA22 reports the results conditional on market conditions.

Table IA1
Variable definitions

Variable	Definition
Beta estimates	
Fund beta	A bond's fund beta is the par-weighted average beta across all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated from the 24-month rolling regression of the fund's monthly excess return on CRSP excess return, requiring at least 18 observations. *Fund beta* is decomposed into: 1) *Direct fund beta*, the coefficient β_1 on *Excess stock market return* from Equation 3 in Section 2.1, and 2) *Indirect fund beta*, the remaining component. *Indirect fund beta* is further expressed as the product of: 3) *Fund muni beta*, the coefficient β_2 on *Excess muni market return* in Equation 3, and 4) *Aggregate muni beta*, the sensitivity of the excess muni market return to the excess stock market return. *Excess stock market return* and *Excess muni market return* are the monthly returns on the CRSP stock index and the Bloomberg Municipal Bond index, respectively, in excess of the one-month Treasury bill rate.
Bond beta	A bond's beta (muni beta) is estimated from the 24-month rolling regression of the bond's monthly excess return on the excess stock (muni) market return, requiring at least 12 observations.
Bond characteristics	
Yield	The transaction's trading yield, in basis points.
Yield spread	The difference between yield, adjusted for federal and state taxes, and the maturity-matched Treasury rate on the same date, in basis points.
Par traded	The trade's par traded amount, in $ millions.
Sale	Indicator of whether the trade is a customer sale versus purchase.
Fund trade	Indicator of whether the trade is by an open-end muni fund.
Flow pressure	The sum of the (expected) net outflows associated with all funds' positions in the bond, scaled by the bond's offering amount. For each fund, the expected net outflows, scaled by fund size, are forecast from the 24-month rolling regression of net outflows on lagged net outflows and lagged return.
Cash	The par-weighted average cash-to-assets ratio across all open-end municipal bond funds holding the bond as of the previous month.
Family's equity fund share	The par-weighted average family-level equity fund share across all open-end municipal bond funds holding the bond as of the previous month.
Retail share	The par-weighted average share of retail share classes across all open-end municipal bond funds holding the bond as of the previous month.
Portfolio dispersion	The par-weighted average portfolio dispersion across all open-end municipal bond funds holding the bond as of the previous month. At the fund level, portfolio dispersion is the standard deviation of the portfolio bonds' maturity or numeric rating.

(Continued)

Table IA1—*Continued*

Variable	**Definition**
Puerto Rico exposure	The bond's exposure to Puerto Rico debts through its holding funds. For each fund, we calculate the portfolio share of Puerto Rico bonds. Each portfolio position's par amount is then adjusted by multiplying with the holding fund's Puerto Rico bond share. The final Puerto Rico exposure measure, at the bond-month level, is the sum of the adjusted par amount across all open-end municipal bond funds holding the bond as of the previous month, scaled by the bond's offering amount.
Mutual fund holding	The bond's par amount held by open-end muni funds as of the previous month, scaled by the offering amount, in %.
# holding funds	The number of open-end muni funds holding the bond as of the previous month.
Offering amount	The bond's offering amount, in $ millions.
Callable bond	Indicator of whether bond b is callable.
General obligation bond	Indicator of whether the bond is general obligation bond.
Insured bond	Indicator of whether the bond is insured.
Credit-enhanced bond	Indicator of whether the bond has any credit enhancement.
Bank-qualified bond	Indicator of whether the bond is bank qualified.
Bond age	Number of years since the offering date.
Bond maturity	Number of years until maturity.
Bond turnover	The bond's customer trading amount in the previous month, scaled by the offering amount, in %.
Bond rating	The bond's rating on the trading day—the median of Moody's, S&P, and Fitch ratings when all are available, or lower rating otherwise. Bond ratings are encoded so that AAA = 0, AA+ = 1, ..., BB+ = 10, ..., C = 20. Unrated bonds are treated as one separate rating category.
Market conditions	
Sentiment	The monthly University of Michigan Consumer Sentiment Index.
DOX	The monthly degree of extrapolative weighting (Cassella and Gulen, 2018).
Market markup	Daily par-weighted dealer markup across all customer trades, in %.
VIX	Daily value of the Chicago Board Options Exchange's CBOE Volatility Index.
Aggregate net outflows	Daily net outflow-to-assets ratio of open-end municipal bond funds, in %. Daily fund flows are available from Morningstar starting in 2009.

Figure IA1
Mutual fund ownership share of the U.S. municipal bond market, 2007–2021

This figure plots the share of total U.S. municipal securities outstanding held by open-end mutual funds, money market funds, closed-end funds, and exchange-traded funds at quarter-end. Shaded bars indicate the 2008–09 financial crisis, the 2013 Taper Tantrum, and the onset of the COVID-19 pandemic in early 2020. Source: Financial Accounts of the United States Z.1, Table L.212 (March 2026 release).

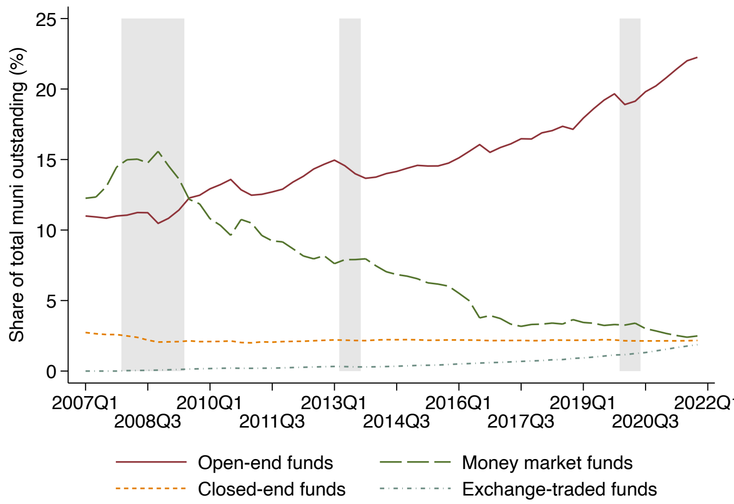


Figure IA2
Fund beta decomposition

This diagram illustrates how *fund beta* is decomposed into *direct fund beta* and *indirect fund beta*, with the latter being the product of *fund muni beta* and *aggregate muni beta*.

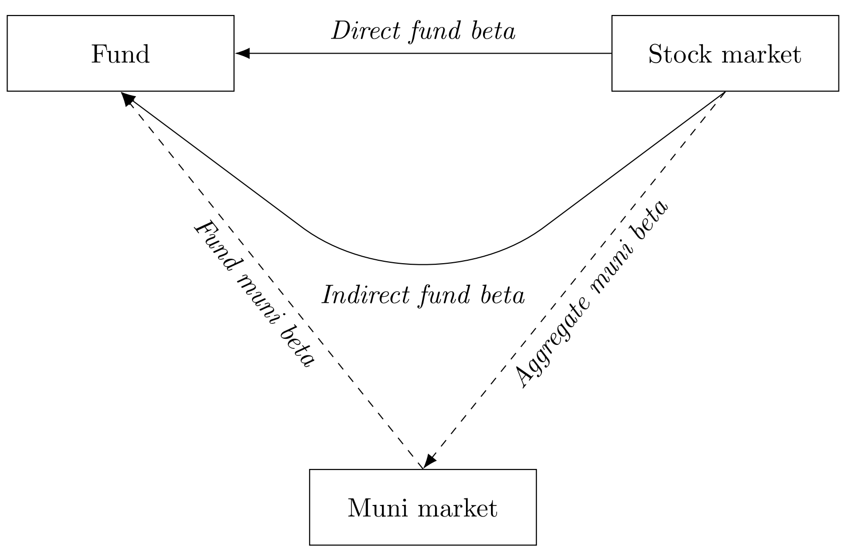
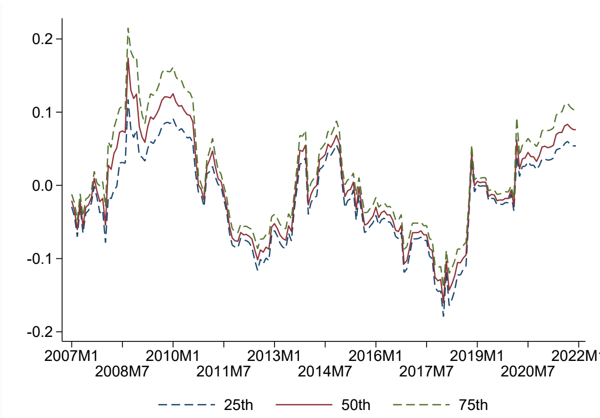


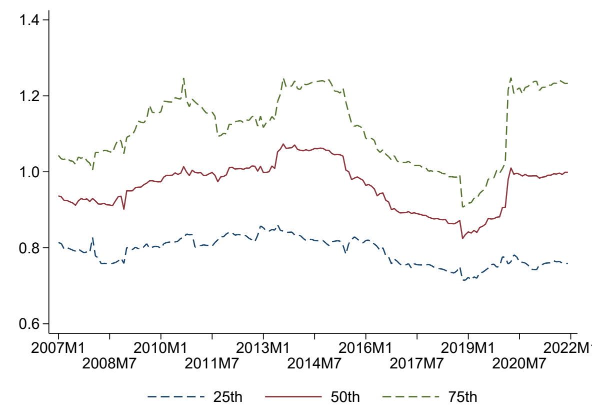
Figure IA3
Fund beta: Time series

This figure plots the time series of the sensitivity of fund return to the stock market return (*Fund beta*), the sensitivity of fund return to the muni market return (*Fund muni beta*), and the sensitivity of the muni market return to the stock market return (*Aggregate muni beta*).

(a) Fund beta



(b) Fund muni beta



(c) Aggregate muni beta

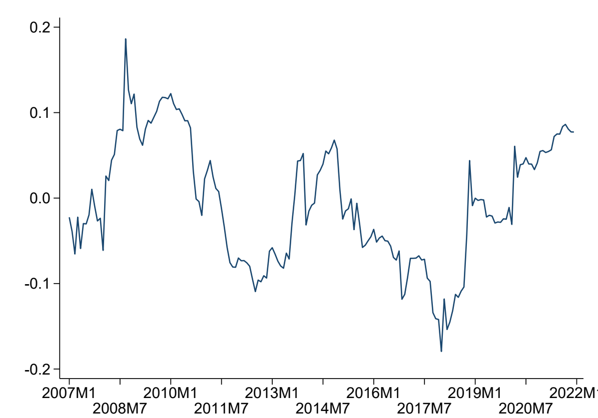
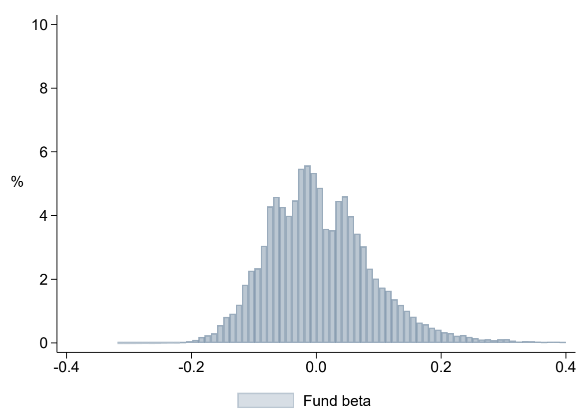


Figure IA4
Fund beta distribution

This figure plots the distribution of *fund beta* and its two components—*direct fund beta* and *indirect fund beta*. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations.

(a) Fund beta



(b) Direct and indirect fund betas

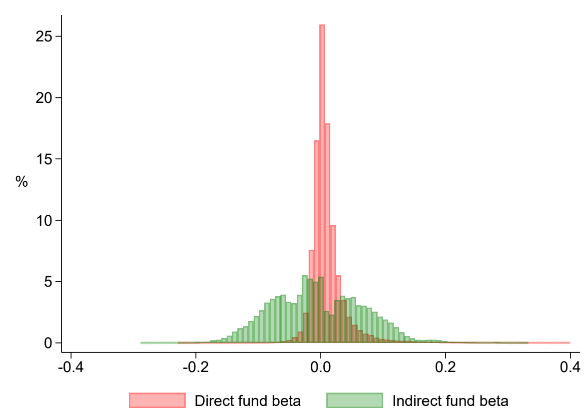
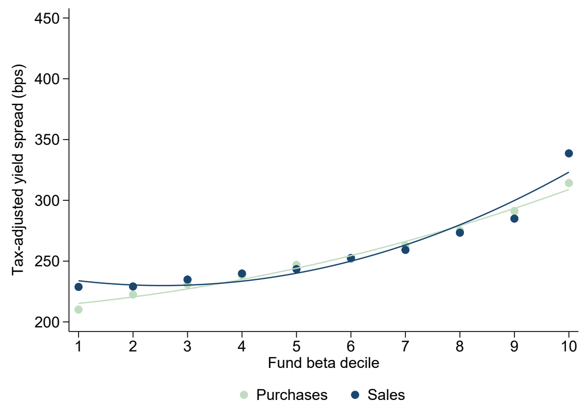


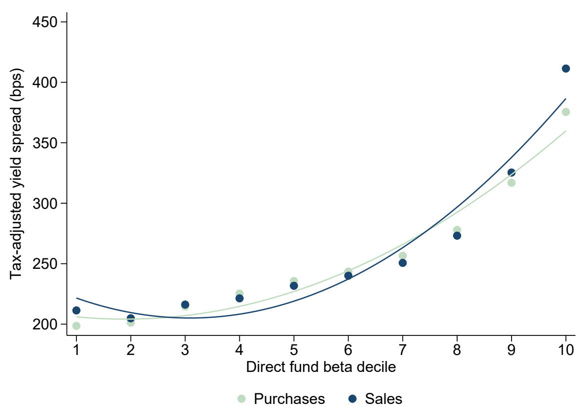
Figure IA5
Purchases versus sales

This figure plots the average tax-adjusted yield spread of fund beta deciles. The sample is split into deciles based on the bond's *fund beta*, *direct fund beta*, or *indirect fund beta* for each trading day and for purchases and sales separately. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations.

(a) Fund beta



(b) Direct fund beta



(c) Indirect fund beta

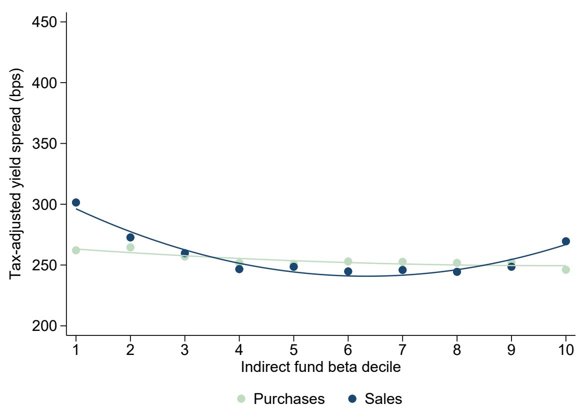


Figure IA6
Puerto Rico government debt crisis: Google search interest

This figure illustrates weekly search interest in the topic of *Puerto Rican government-debt crisis*. According to Google Trends, "numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. A score of 0 means there was not enough data for this term."

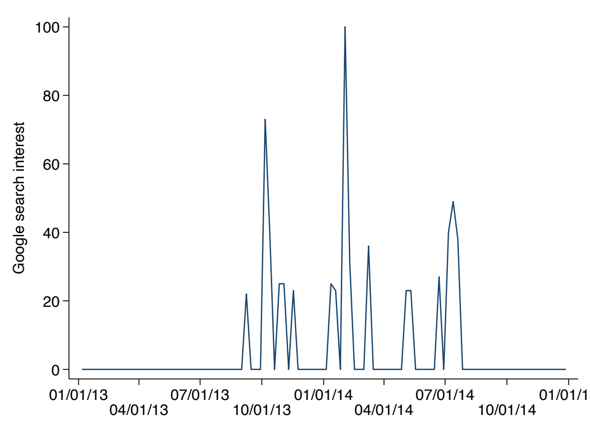
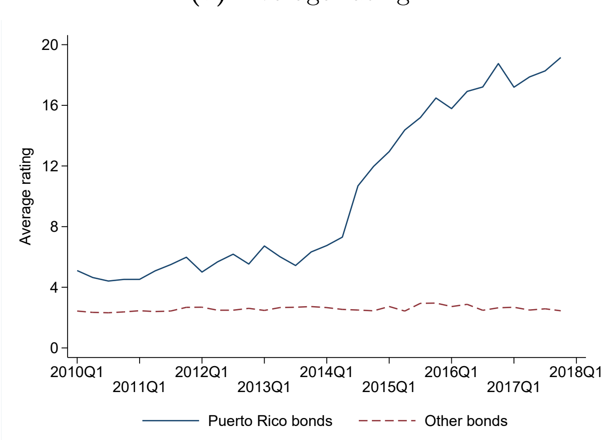


Figure IA7
Performance of Puerto Rico bonds

This figure reports the performance of Puerto Rico bonds between 2010 and 2017. Panel A plots the quarterly par-weighted average ratings of trades on Puerto Rico bonds versus trades on other bonds. Unrated bond trades are excluded. Bond ratings are encoded so that AAA = 0, AA+ = 1, ..., BB+ = 10, ..., C = 20. Panel B plots the cumulative quarterly returns of the S&P Municipal Bond Puerto Rico Index versus the S&P Municipal Bond (Investment Grade) Index and the S&P Municipal Bond High Yield Index.

(a) Average rating



(b) Cumulative return (%)

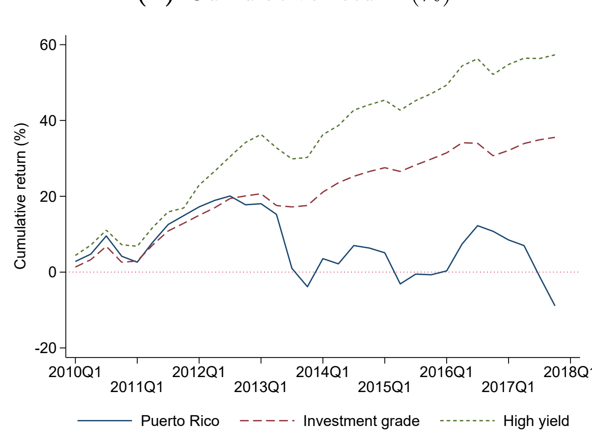


Figure IA8
Non-Puerto Rico bond rating and Puerto Rico exposure

Subfigure (a) plots the sensitivity, along with its 95% confidence intervals, of fund-level average rating of non-Puerto Rico bonds to the fund's Puerto Rico portfolio share, measured as of 2012Q3, between 2012Q4 and 2014Q4. Puerto Rico portfolio share is standardized to have a mean of zero and a standard deviation of one. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund.

Subfigure (b) plots the sensitivity, along with its 95% confidence intervals, of non-Puerto Rico bonds' monthly rating to bond-level Puerto Rico exposure, measured as of 2012Q3, between 2012Q4 and 2014Q4. *Puerto Rico exposure* is the bond's par amount held by open-end muni funds, adjusted for the holding funds' portfolio share of Puerto Rico bonds, following Equation 9 in Section 5.5. Puerto Rico exposure is standardized to have a mean of zero and a standard deviation of one. The unit of observation is a bond-month. Standard errors are adjusted for clustering by bond and year-month.

Bond ratings are encoded so that AAA = 0, AA+ = 1, . . . , BB+ = 10, . . . , C = 20.

(a) Fund level **(b)** Bond level

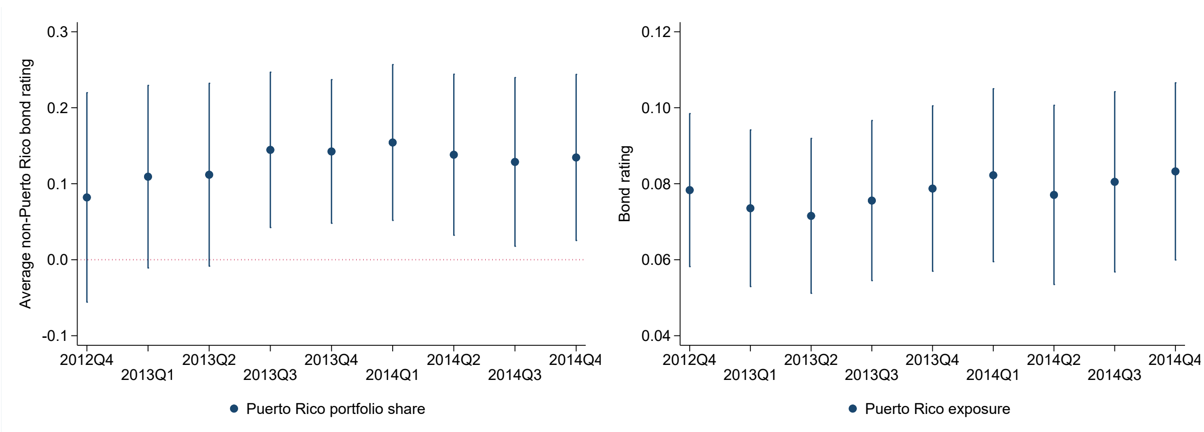


Table IA2
Fund beta correlations

This table reports the correlation coefficients for fund beta and its components. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. *Fund beta* is decomposed into: 1) *Direct fund beta*, the coefficient β_1 on *Excess stock market return* from Equation 3 in Section 2.1, and 2) *Indirect fund beta*, the remaining component. *Indirect fund beta* is further expressed as the product of: 3) *Fund muni beta*, the coefficient β_2 on *Excess muni market return* in Equation 3, and 4) *Aggregate muni beta*, the sensitivity of the excess muni market return to the excess stock market return. We also report the correlation coefficients between fund beta and its components and measures of mutual fund holding, holding funds' 12-month average return, and the bond's flow pressure. The sample period is 2007–2021.

	Fund beta	Direct fund beta	Indirect fund beta	Fund muni beta	Aggregate muni beta	Mutual fund holding	Fund return	Flow pressure
Fund beta	1.00	0.59	0.93	0.22	0.88	0.03	−0.04	−0.06
Direct fund beta	0.59	1.00	0.25	0.35	0.21	0.07	−0.12	0.01
Indirect fund beta	0.93	0.25	1.00	0.11	0.96	0.00	0.00	−0.07
Fund muni beta	0.22	0.35	0.11	1.00	0.09	0.10	0.17	0.06
Aggregate muni beta	0.88	0.21	0.96	0.09	1.00	0.00	−0.01	−0.09
Mutual fund holding	0.03	0.07	0.00	0.10	0.00	1.00	0.02	−0.11
Fund return	−0.04	−0.12	0.00	0.17	−0.01	0.02	1.00	−0.16
Flow pressure	−0.06	0.01	−0.07	0.06	−0.09	−0.11	−0.16	1.00

Table IA3
Purchases versus sales

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds for purchases and sales separately:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	Customer purchases		Customer sales	
	(1)	(2)	(3)	(4)
Fund beta$_{b,m-1}$	24.984***		24.543***	
	(2.006)		(2.454)	
Direct fund beta$_{b,m-1}$		15.638***		20.121***
		(0.918)		(1.148)
Indirect fund beta$_{b,m-1}$		−1.359		−10.976***
		(2.096)		(2.061)
Ln(Par traded)$_{b,t}$	−9.211***	−9.181***	−22.755***	−22.753***
	(0.213)	(0.212)	(0.274)	(0.272)
Mutual fund holding$_{b,m-1}$	7.844***	7.818***	6.827***	6.929***
	(0.636)	(0.629)	(0.661)	(0.651)
Ln(Offering amount)$_b$	−1.686*	−1.997**	0.653	0.232
	(0.930)	(0.931)	(0.997)	(0.987)
Callable bond$_b$	−34.813***	−35.182***	2.406	2.145
	(2.243)	(2.236)	(1.772)	(1.761)
General obligation bond$_b$	3.570	4.371	4.202	5.201
	(5.739)	(5.868)	(4.187)	(4.149)
Insured bond$_b$	8.117***	8.627***	21.431***	21.708***
	(2.710)	(2.698)	(3.008)	(2.983)
Credit-enhanced bond$_b$	−6.844	−7.241	−8.732	−9.456
	(6.915)	(6.916)	(9.208)	(9.215)
Bank-qualified bond$_b$	8.657	8.187	33.741*	33.533*
	(11.194)	(11.129)	(17.391)	(17.210)
Ln(Bond age)$_{b,t}$	−46.919***	−46.873***	−32.674***	−32.777***
	(0.894)	(0.893)	(0.945)	(0.938)
Ln(Bond maturity)$_{b,t}$	36.416***	35.485***	18.534***	17.301***
	(1.173)	(1.171)	(1.057)	(1.028)
Bond turnover$_{b,m-1}$	3.091***	3.036***	1.833***	1.598***
	(0.234)	(0.235)	(0.337)	(0.332)
N	10,634,563	10,634,563	5,373,236	5,373,236
Adjusted R^2	0.82	0.82	0.76	0.76
Issuer×Date FEs	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓

Table IA4
Fund beta determinants: Fund level

This table reports results of regressions of a fund's beta on its characteristics:

$$Fund\ beta_{f,m} = \alpha_m + \beta \times \eta' \mathbf{X}_{f,m-1} + \varepsilon_{f,m},$$

where f indexes funds and m year-months. Fund-level beta is estimated from the 24-month rolling regression of the fund's monthly excess return on CRSP excess return, requiring at least 18 observations. All continuous variables, including fund betas, are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Fund beta	Direct fund beta	Indirect fund beta	Fund muni beta
	(1)	(2)	(3)	(4)
Net outflows$_{f,m-12,\to m-1}$	0.028***	0.011	0.028***	0.018***
	(0.006)	(0.008)	(0.005)	(0.005)
Fund return$_{f,m-12,\to m-1}$	−0.490***	−1.053***	−0.063***	0.281***
	(0.026)	(0.049)	(0.013)	(0.021)
Ln(Fund TNA)$_{f,m-1}$	−0.000	0.008	−0.005	−0.039*
	(0.012)	(0.023)	(0.005)	(0.022)
Ln(Family TNA)$_{f,m-1}$	0.011	0.009	0.009**	−0.006
	(0.010)	(0.020)	(0.004)	(0.019)
Fund age$_{f,m-1}$	−0.038***	−0.085***	−0.003	−0.022
	(0.009)	(0.019)	(0.003)	(0.014)
Retail share$_{f,m-1}$	0.011	0.015	0.006*	−0.023*
	(0.008)	(0.015)	(0.003)	(0.013)
Short-term fund$_f$	0.055	0.098	0.018	−0.821***
	(0.045)	(0.088)	(0.017)	(0.073)
Single-state fund$_f$	−0.007	−0.031	0.007	0.002
	(0.020)	(0.041)	(0.008)	(0.042)
Index fund$_f$	−0.063	−0.331***	0.089**	−0.076
	(0.043)	(0.083)	(0.035)	(0.108)
Cash/TNA$_{f,m-1}$	−0.025**	−0.074***	0.006	−0.291***
	(0.011)	(0.021)	(0.007)	(0.019)
Management fee$_f$	−0.016*	−0.033**	−0.002	−0.037***
	(0.009)	(0.016)	(0.004)	(0.014)
Portfolio HHI$_{f,m-1}$	−0.002	0.008	−0.007**	−0.021*
	(0.008)	(0.016)	(0.003)	(0.011)
Ln(Portfolio offering amount)$_{f,m-1}$	0.009	0.018	0.002	−0.000
	(0.011)	(0.022)	(0.005)	(0.019)
Ln(Portfolio bond age)$_{f,m-1}$	−0.037***	−0.035*	−0.027***	−0.134***
	(0.010)	(0.018)	(0.006)	(0.016)
Ln(Portfolio bond maturity)$_{f,m-1}$	0.121***	0.254***	0.018*	0.590***
	(0.022)	(0.040)	(0.010)	(0.040)
Portfolio callable bond share$_{f,m-1}$	−0.054***	−0.059*	−0.035***	−0.174***
	(0.018)	(0.034)	(0.009)	(0.031)
Portfolio GO bond share$_{f,m-1}$	−0.001	0.012	−0.007*	0.026
	(0.009)	(0.017)	(0.004)	(0.017)
Portfolio insured bond share$_{f,m-1}$	−0.053***	−0.157***	0.015***	0.056***
	(0.013)	(0.025)	(0.006)	(0.020)
Portfolio credit-enhanced bond share$_{f,m-1}$	−0.021***	−0.029*	−0.010***	−0.040***
	(0.008)	(0.015)	(0.004)	(0.015)
Portfolio bank-qualified bond share$_{f,m-1}$	0.003	−0.003	0.005	−0.042**
	(0.011)	(0.022)	(0.004)	(0.019)
Portfolio rated bond share$_{f,m-1}$	−0.136***	−0.255***	−0.036***	−0.034
	(0.019)	(0.039)	(0.007)	(0.039)
Portfolio bond rating$_{f,m-1}$	0.111***	0.253***	0.007	0.161***
	(0.012)	(0.026)	(0.005)	(0.021)
N	93,345	93,345	93,345	93,345
Adjusted R^2	0.80	0.36	0.90	0.69
Year-month FEs	✓	✓	✓	✓

Table IA5
Fund beta determinants: Bond level

This table reports results of regressions of a bond's fund beta on its characteristics:

$$Fund\ beta_{b,m} = \alpha_{i,m} + \beta \times \eta' \mathbf{X}_{b,m-1} + \varepsilon_{b,m},$$

where b indexes bonds, i issuers, and m year-months. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. All continuous variables, including fund betas, are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a bond-month. Standard errors are adjusted for clustering by bond. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Fund beta	Direct fund beta	Indirect fund beta	Fund muni beta
	(1)	(2)	(3)	(4)
Mutual fund holding$_{b,m-1}$	0.005***	0.012***	0.000	0.041***
	(0.001)	(0.002)	(0.000)	(0.002)
Ln(Offering amount)$_b$	0.031***	0.059***	0.008***	0.001
	(0.001)	(0.002)	(0.001)	(0.002)
Callable bond$_b$	−0.024***	−0.013***	−0.023***	0.231***
	(0.002)	(0.003)	(0.001)	(0.005)
General obligation bond$_b$	0.009	0.012	0.006	−0.004
	(0.006)	(0.012)	(0.004)	(0.015)
Insured bond$_b$	−0.009***	−0.013***	−0.004***	0.041***
	(0.003)	(0.005)	(0.001)	(0.006)
Credit-enhanced bond$_b$	−0.001	−0.010	0.003	−0.008
	(0.005)	(0.010)	(0.003)	(0.011)
Bank-qualified bond$_b$	0.031***	0.082***	−0.003	−0.065***
	(0.008)	(0.016)	(0.005)	(0.021)
Ln(Bond age)$_{b,m-1}$	0.010***	0.025***	−0.000	0.123***
	(0.001)	(0.001)	(0.001)	(0.002)
Ln(Bond maturity)$_{b,m-1}$	0.012***	0.067***	−0.019***	0.495***
	(0.001)	(0.002)	(0.001)	(0.002)
Bond turnover$_{b,m-1}$	0.002***	0.007***	−0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Bond rating$_{b,m-1}$	0.058***	0.128***	0.006***	0.090***
	(0.002)	(0.004)	(0.001)	(0.003)
N	10,108,333	10,108,333	10,108,333	10,108,333
Adjusted R^2	0.85	0.34	0.92	0.50
Issuer×Year-month FEs	✓	✓	✓	✓

Table IA6
Aggregate muni beta and net outflows

This table reports results of regressions of a fund's net outflows on the aggregate muni beta:

$$\textit{Net outflows (\%)}_{f,m} = \alpha_m + \beta \times \textit{Aggregate muni beta}_{m-1} + \eta'\mathbf{X}_{f,m-1} + \varepsilon_{f,m},$$

where f indexes funds and m year-months. *Aggregate muni beta* is estimated from the 24-month rolling regression of the excess muni market return on the excess stock market return. For each fund, the expected fund net outflows, scaled by fund size, are forecast from the 24-month rolling regression of net outflows on lagged net outflows and lagged return. Unexpected net outflows are the difference between the realized and expected net outflows. Fund characteristics in Table IA4 are included but omitted for brevity. All continuous explanatory variables, excluding fund flows and returns, are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Realized outflows (%)		Expected outflows (%)		Unexpected outflows (%)	
	(1)	(2)	(3)	(4)	(5)	(6)
Aggregate muni beta$_{f,m-1}$	−0.091***	−0.442***	−0.058***	−0.208***	−0.035***	−0.214***
	(0.007)	(0.034)	(0.009)	(0.021)	(0.009)	(0.038)
Net outflows$_{f,m-1}$	0.322***	0.310***	0.335***	0.340***	−0.025***	−0.042***
	(0.008)	(0.008)	(0.009)	(0.009)	(0.006)	(0.007)
Net outflows$_{f,m-2}$	0.164***	0.163***	0.150***	0.155***	0.010	0.004
	(0.007)	(0.006)	(0.005)	(0.005)	(0.007)	(0.006)
Net outflows$_{f,m-3}$	0.119***	0.130***	0.128***	0.136***	−0.008	−0.004
	(0.006)	(0.006)	(0.004)	(0.004)	(0.006)	(0.006)
Fund return$_{f,m-1}$	−0.178***	−0.107***	−0.149***	−0.144***	−0.029***	0.039***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.007)	(0.009)
Fund return$_{f,m-2}$	−0.003	0.055***	0.037***	0.036***	−0.041***	0.020**
	(0.007)	(0.008)	(0.004)	(0.005)	(0.007)	(0.008)
Fund return$_{f,m-3}$	−0.011**	0.029***	0.047***	0.030***	−0.058***	0.000
	(0.005)	(0.006)	(0.003)	(0.004)	(0.006)	(0.007)
N	93,345	93,345	93,345	93,345	93,345	93,345
Adjusted R^2	0.30	0.33	0.56	0.57	0.01	0.06
Dependent variable mean	−0.322	−0.322	−0.387	−0.387	0.068	0.068
Dependent variable SD	2.380	2.380	1.802	1.802	2.211	2.211
Fund controls	✓	✓	✓	✓	✓	✓
Quarter-month FEs		✓		✓		✓

Table IA7
Fund beta and monthly trading amount

This table reports results of regressions of a fund's trading amount on its beta:

$$\textit{Trading amount (\%)}_{f,m} = \alpha_m + \beta \times \textit{Fund beta}_{f,m-1} + \eta' \mathbf{X}_{f,m-1} + \varepsilon_{f,m},$$

where f indexes funds and m year-months. Fund-level beta is estimated from the 24-month rolling regression of the fund's monthly excess return on CRSP excess return, requiring at least 18 observations. Sale and purchase amounts are inferred from the changes in fund holdings, excluding those explained by bond events such as bond maturity and redemptions. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	Sale/TNA (%)		Purchase/TNA (%)	
	(1)	(2)	(3)	(4)
Fund beta$_{f,m-1}$	0.130***	0.080**	−0.219***	−0.186***
	(0.035)	(0.039)	(0.049)	(0.051)
Fund beta$_{f,m-1}\times$ VIX$_m$		0.064***		−0.042**
		(0.021)		(0.020)
Ln(Fund TNA)$_{f,m-1}$	−0.106*	−0.105*	−0.086	−0.086
	(0.063)	(0.063)	(0.053)	(0.053)
Ln(Family TNA)$_{f,m-1}$	−0.177***	−0.178***	−0.111***	−0.110***
	(0.037)	(0.037)	(0.041)	(0.041)
Fund age$_{f,m-1}$	−0.024	−0.025	−0.200***	−0.199***
	(0.030)	(0.030)	(0.043)	(0.043)
Retail share$_{f,m-1}$	−0.151***	−0.152***	−0.149***	−0.148***
	(0.045)	(0.045)	(0.048)	(0.048)
Short-term fund$_f$	−0.244*	−0.228	−0.011	−0.021
	(0.141)	(0.141)	(0.172)	(0.173)
Single-state fund$_f$	−0.425***	−0.427***	−0.440***	−0.438***
	(0.096)	(0.096)	(0.104)	(0.104)
Index fund$_f$	−0.168	−0.167	0.509	0.508
	(0.221)	(0.222)	(1.173)	(1.173)
Cash/TNA$_{f,m-1}$	−0.168***	−0.167***	0.162***	0.161***
	(0.035)	(0.035)	(0.062)	(0.062)
Management fee$_f$	0.026	0.027	−0.073*	−0.074*
	(0.039)	(0.039)	(0.041)	(0.041)
Portfolio HHI$_{f,m-1}$	0.088	0.089	−0.078*	−0.079*
	(0.086)	(0.087)	(0.047)	(0.046)
N	93,345	93,345	93,345	93,345
Adjusted R^2	0.17	0.17	0.17	0.18
Dependent variable mean	1.464	1.464	2.287	2.287
Dependent variable SD	2.268	2.268	2.499	2.499
Portfolio characteristic controls	✓	✓	✓	✓
Year-month FEs	✓	✓	✓	✓

Table IA8
Retail, sentiment, and extrapolation

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with measures of the average of holding funds' share of retail share classes:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Retail share}_{b,m-1} + \eta'\mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. *Retail share* is the par-weighted average share of retail share classes across all open-end municipal bond funds holding the bond as of the previous month. *Sentiment* is the University of Michigan Consumer Sentiment Index. *DOX* is the degree of extrapolative weighting from Cassella and Gulen (2018). All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)
Fund beta$_{b,m-1}$	25.140***		12.273***	27.197***
	(2.040)		(1.661)	(2.170)
Fund beta$_{b,m-1}$× Retail share$_{b,m-1}$	1.912***			
	(0.418)			
Direct fund beta$_{b,m-1}$		17.209***		
		(0.938)		
Indirect fund beta$_{b,m-1}$		−5.455***		
		(1.949)		
Direct fund beta$_{b,m-1}$× Retail share$_{b,m-1}$		3.384***		
		(0.526)		
Indirect fund beta$_{b,m-1}$× Retail share$_{b,m-1}$		0.775**		
		(0.372)		
Fund beta$_{b,m-1}$× Sentiment$_m$			−19.683***	
			(1.254)	
Fund beta$_{b,m-1}$× DOX$_m$				6.893***
				(1.649)
Retail share$_{b,m-1}$	2.780***	3.374***		
	(0.423)	(0.439)		
N	18,004,526	18,004,526	18,012,021	14,157,413
Adjusted R^2	0.77	0.77	0.77	0.76
Bond controls	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓

Table IA9
Net inflows and fund return: Retail versus institutional share classes

This table reports results of regressions of a share class's net inflows on the fund's lagged returns:

$$\textit{Net inflows (\%)}_{sc,f,m} = \alpha_{f,m} + \beta \times \textit{Fund return (\%)}_{f,m-1} \times \textit{Retail share class}_{sc,f} + \varepsilon_{sc,m},$$

where sc indexes share classes, f funds, and m year-months. Panel A (Panel B) restricts the sample to share classes of funds with negative (positive) returns over the last six months. The unit of observation is a share class-month. Standard errors are adjusted for clustering by fund. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Panel A: Six-month fund return ≤ 0					
	Retail share classes		Institutional share classes		
	(1)	(2)	(3)	(4)	(5)
Fund return$_{f,m-6\to m-1}$	0.064***		−0.034		
	(0.022)		(0.069)		
Fund return$_{f,m-6\to m-1}\times$ Retail$_{sc,f}$					0.235***
					(0.068)
Retail share class$_{sc,f}$					−1.097***
					(0.208)
Fund return$_{f,m-1}$		0.148***		0.040	
		(0.039)		(0.154)	
Fund return$_{f,m-2}$		0.157***		−0.062	
		(0.039)		(0.127)	
Fund return$_{f,m-3}$		0.087		−0.108	
		(0.054)		(0.116)	
Fund return$_{f,m-4}$		−0.195***		−0.221	
		(0.057)		(0.144)	
Fund return$_{f,m-5}$		0.149**		0.154	
		(0.076)		(0.156)	
Fund return$_{f,m-6}$		−0.008		0.179	
		(0.053)		(0.124)	
N	56,370	56,370	14,683	14,683	66,624
Adjusted R^2	0.02	0.02	0.03	0.03	−0.03
Year-month FEs	✓	✓	✓	✓	
Fund×Year-month FEs					✓

Panel B: Six-month fund return > 0					
	Retail share classes		Institutional share classes		
	(1)	(2)	(3)	(4)	(5)
Fund return$_{f,m-6\to m-1}$	0.127***		0.523***		
	(0.036)		(0.075)		
Fund return$_{f,m-6\to m-1}\times$ Retail$_{sc,f}$					−0.264***
					(0.048)
Retail share class$_{sc,f}$					−1.259***
					(0.157)
Fund return$_{f,m-1}$		0.041		0.952***	
		(0.083)		(0.165)	
Fund return$_{f,m-2}$		0.028		0.401**	
		(0.069)		(0.166)	
Fund return$_{f,m-3}$		0.164***		0.686***	
		(0.059)		(0.150)	
Fund return$_{f,m-4}$		0.262***		0.359***	
		(0.054)		(0.098)	
Fund return$_{f,m-5}$		0.120**		0.555***	
		(0.057)		(0.169)	
Fund return$_{f,m-6}$		0.157***		0.264**	
		(0.039)		(0.110)	
N	186,167	186,167	54,121	54,121	222,736
Adjusted R^2	0.00	0.00	0.01	0.01	−0.10
Year-month FEs	✓	✓	✓	✓	
Fund×Year-month FEs					✓

Table IA10
Upside and downside fund betas

This table reports results of regressions of a bond's tax-adjusted yield spread on the upside and downside fund betas:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta^+ \times \textit{Fund beta}^+_{b,m-1} + \beta^- \times \textit{Fund beta}^-_{b,m-1} + \eta'\mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level betas are estimated using a 24-month rolling regression of the fund's monthly excess return on *max(0, CRSP excess return)* and *min(0, CRSP excess return)*, requiring a minimum of 18 observations. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$^+_{b,m-1}$	24.273***					
	(1.893)					
Fund beta$^-_{b,m-1}$	19.961***					
	(1.702)					
Direct fund beta$^+_{b,m-1}$		9.742***		9.364***		
		(0.658)		(0.622)		
Direct fund beta$^-_{b,m-1}$		13.684***		13.708***		
		(0.921)		(0.879)		
Indirect fund beta$^+_{b,m-1}$			15.883***	4.865**		
			(2.931)	(2.400)		
Indirect fund beta$^-_{b,m-1}$			2.300	−4.537***		
			(1.923)	(1.640)		
Fund muni beta$^+_{b,m-1}$					19.735***	
					(1.263)	
Fund muni beta$^-_{b,m-1}$					12.275***	
					(0.733)	
Aggregate muni beta$^+_{m-1}$						2.115
						(2.346)
Aggregate muni beta$^-_{m-1}$						−4.020***
						(1.029)
N	18,012,021	18,012,021	18,012,021	18,012,021	18,012,021	18,012,021
Adjusted R^2	0.77	0.77	0.77	0.77	0.78	0.70
Bond controls	✓	✓	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓	✓	
Issuer×Year-quarter FEs						✓
Rating FEs	✓	✓	✓	✓	✓	✓

Table IA11
Fund identity

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds:

$$Yield\ spread\ (bps)_{b,t} = \alpha_{i,m} + \alpha_{f,m} + \alpha_r + \beta \times Fund\ beta_{b,m-1} + \eta'\mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, f funds, i issuers, r ratings, and m year-months, and t trading days. The sample is limited to trades by open-end municipal bond funds. Columns 1–4 use bond-level *fund beta*—the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Columns 5–6 use the beta of the specific trading fund executing the transaction. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{b,m-1}$	74.132***	38.602***	22.320***	13.746***		11.594***
	(3.281)	(2.454)	(2.793)	(2.958)		(2.678)
Fund beta$_{f,m-1}$					11.063***	6.589***
					(1.683)	(1.633)
Ln(Par traded)$_{b,t}$	−0.479	−3.493***	−5.065***	−7.082***	−6.082***	−6.090***
	(1.265)	(1.080)	(0.898)	(0.727)	(0.772)	(0.771)
Net outflows$_{f,t}$	−0.375	0.855	2.654*	2.757***	4.563***	4.557***
	(1.323)	(1.218)	(1.483)	(0.953)	(0.852)	(0.851)
Ln(Fund TNA)$_{f,m-1}$					−10.564***	−10.463***
					(1.764)	(1.762)
Ln(Family TNA)$_{f,m-1}$					−0.100	0.076
					(1.705)	(1.705)
Mutual fund holding$_{b,m-1}$		18.484***	13.154***	−1.936	−0.656	−0.834
		(1.005)	(1.436)	(1.240)	(1.293)	(1.295)
Ln(Offering amount)$_b$		−3.282***	−7.220***			
		(1.238)	(1.468)			
Callable bond$_b$		−48.511***	−16.055***			
		(2.839)	(3.047)			
General obligation bond$_b$		2.487	8.673			
		(1.667)	(6.437)			
Insured bond$_b$		−16.122***	−13.364***			
		(2.527)	(4.142)			
Credit-enhanced bond$_b$		−17.647***	−6.705			
		(3.562)	(7.932)			
Bank-qualified bond$_b$		−18.189***	10.431			
		(5.439)	(31.858)			
Ln(Bond age)$_{b,t}$		−23.361***	−29.564***	21.565***	27.381***	27.080***
		(1.073)	(1.575)	(2.288)	(2.797)	(2.786)
Ln(Bond maturity)$_{b,t}$		41.446***	38.467***	−59.703***	−67.940***	−66.907***
		(1.644)	(1.985)	(3.685)	(3.880)	(3.869)
Bond turnover$_{b,m-1}$		4.776***	3.019***	0.822**	1.072***	1.094***
		(0.570)	(0.712)	(0.396)	(0.375)	(0.375)
N	215,504	215,504	146,169	167,875	169,510	169,510
Adjusted R^2	0.55	0.65	0.87	0.85	0.82	0.82
Fund FEs					✓	✓
Year-month FEs					✓	✓
Fund×Year-month FEs	✓	✓	✓	✓		
Issuer×Year-month FEs			✓			
Bond FEs				✓	✓	✓
Rating FEs		✓	✓	✓	✓	✓

Table IA12
Open-end funds versus closed-end funds

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its open-end and closed-end holding funds:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta'\mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. A bond's *fund beta* is defined as the par-weighted average beta of all open-end municipal bond funds holding the bond as of the previous month. Fund-level beta is estimated using a 24-month rolling regression of the fund's monthly excess return on the CRSP excess return, requiring a minimum of 18 observations. *Closed-end fund beta* is calculated similarly but based on all closed-end municipal bond funds holding the bond as of the previous month. The sample includes bonds held by both open-end and closed-end municipal bond funds as of the previous month. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Fund beta$_{b,m-1}$	55.649***				53.271***	
	(6.156)				(5.825)	
Closed-end fund beta$_{b,m-1}$			27.795***		16.133***	
			(6.302)		(4.711)	
Direct fund beta$_{b,m-1}$		25.638***				24.597***
		(2.319)				(2.208)
Indirect fund beta$_{b,m-1}$		18.619**				17.825**
		(7.881)				(7.681)
Direct closed-end fund beta$_{b,m-1}$				12.686***		8.423***
				(2.397)		(1.989)
Indirect closed-end fund beta$_{b,m-1}$				13.083**		6.083
				(6.405)		(4.975)
Ln(Par traded)$_{b,t}$	−5.769***	−5.751***	−5.606***	−5.594***	−5.835***	−5.804***
	(0.407)	(0.406)	(0.421)	(0.421)	(0.405)	(0.404)
Mutual fund holding$_{b,m-1}$	5.927***	5.878***			5.833***	5.785***
	(1.435)	(1.426)			(1.430)	(1.423)
Closed-end fund holding$_{b,m-1}$			4.226***	4.111***	3.843***	3.648***
			(1.119)	(1.123)	(1.111)	(1.113)
N	4,517,676	4,517,676	4,517,676	4,517,676	4,517,676	4,517,676
Adjusted R^2	0.83	0.83	0.83	0.83	0.83	0.83
Bond controls	✓	✓	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓

Table IA13
Ownership turnover and selection

This table reports results of regressions of a bond's tax-adjusted yield spread on the components of the change in fund beta:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta change components}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. The *change* in fund beta is decomposed into three components: 1) *Active beta* captures the change in ownership weights holding fund betas constant; 2) *Passive beta* captures the change in fund betas holding ownership weights constant; and 3) *Cross-term beta* is the interaction of changes in weights and changes in fund betas. Column 1 includes issuer-by-date fixed effects. Column 2 includes bond and date fixed effects. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)
Active beta$_{b,m-1}$	3.183***	0.744***
	(0.288)	(0.214)
Passive beta$_{b,m-1}$	2.401*	0.522
	(1.274)	(0.851)
Cross-term beta$_{b,m-1}$	0.132	−0.056
	(0.254)	(0.201)
Fund beta$_{b,m-2}$	26.064***	8.444***
	(2.141)	(1.532)
Ln(Par traded)$_{b,t}$	−12.458***	−10.476***
	(0.221)	(0.186)
Mutual fund holding$_{b,m-1}$	6.687***	−1.020
	(0.620)	(0.914)
N	18,010,867	18,005,727
Adjusted R^2	0.77	0.77
Bond controls	✓	✓
Issuer×Date FEs	✓	
Bond FEs		✓
Date FEs		✓
Rating FEs	✓	✓

Table IA14
Portfolio characteristic dispersion

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with measures of the average of holding funds' portfolio characteristic dispersion:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Portfolio characteristic dispersion}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. *Portfolio characteristic dispersion* is the par-weighted average portfolio dispersion across all open-end municipal bond funds holding the bond as of the previous month. At the fund level, portfolio dispersion is the standard deviation of the portfolio bonds' maturity or numeric rating. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)
Fund beta$_{b,m-1}$	13.354***	23.876***	13.246***
	(1.635)	(2.054)	(1.638)
Fund beta$_{b,m-1}$ × Portfolio rating dispersion$_{b,m-1}$	3.991***		3.601***
	(0.675)		(0.700)
Fund beta$_{b,m-1}$ × Portfolio maturity dispersion$_{b,m-1}$		2.467***	1.632***
		(0.458)	(0.467)
Portfolio rating dispersion$_{b,m-1}$	11.234***		10.927***
	(0.666)		(0.699)
Portfolio maturity dispersion$_{b,m-1}$		3.132***	1.151**
		(0.442)	(0.464)
N	18,010,209	18,010,239	18,010,209
Adjusted R^2	0.77	0.77	0.77
Bond controls	✓	✓	✓
Issuer×Date FEs	✓	✓	✓
Rating FEs	✓	✓	✓

Table IA15
Puerto Rico exposure

This table reports results of regressions from Figures 2–3 in the main paper. In columns 1–2, fund beta (standardized) and monthly net outflows (%) are regressed on fund-level portfolio share of Puerto Rico bonds, measured as of 2012Q3, interacted with indicators for quarters between 2012Q4 and 2014Q4. The unit of observation is a fund-month. Standard errors are adjusted for clustering by fund.
In column 3, tax-adjusted yield spread is regressed on bond-level Puerto Rico exposure, measured as of 2012Q3, interacted with indicators for quarters between 2012Q4 and 2014Q4. *Puerto Rico exposure* is the bond's par amount held by open-end muni funds, adjusted for the holding funds' portfolio share of Puerto Rico bonds, following Equation 9 in Section 5.5. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day.
All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Sample	Fund-month level		Trade level
Dependent variable =	Fund beta (standardized)	Net outflows (%)	Yield spread (bps)
Explanatory variable =	Puerto Rico portfolio share		Puerto Rico exposure
	(1)	(2)	(3)
Explanatory variable			
$\times\mathbb{1}(t \in 2012Q4)$	-0.018^{*}	-0.006	1.397
	(0.010)	(0.097)	(1.641)
$\times\mathbb{1}(t \in 2013Q1)$	-0.003	0.058	1.411
	(0.011)	(0.063)	(1.708)
$\times\mathbb{1}(t \in 2013Q2)$	-0.004	0.050	1.701
	(0.011)	(0.055)	(1.563)
$\times\mathbb{1}(t \in 2013Q3)$	0.054^{***}	0.370^{***}	5.745^{***}
	(0.015)	(0.073)	(1.627)
$\times\mathbb{1}(t \in 2013Q4)$	0.142^{***}	0.295^{***}	9.161^{***}
	(0.035)	(0.062)	(1.463)
$\times\mathbb{1}(t \in 2014Q1)$	0.123^{***}	0.401^{***}	10.952^{***}
	(0.019)	(0.064)	(1.726)
$\times\mathbb{1}(t \in 2014Q2)$	0.195^{***}	0.291^{***}	7.273^{***}
	(0.024)	(0.057)	(1.781)
$\times\mathbb{1}(t \in 2014Q3)$	0.241^{***}	0.291^{***}	7.881^{***}
	(0.024)	(0.055)	(1.855)
$\times\mathbb{1}(t \in 2014Q4)$	0.223^{***}	0.257^{***}	4.584^{**}
	(0.025)	(0.057)	(1.859)
N	13,406	13,406	2,271,241
Adjusted R^2	0.91	0.31	0.74
Dependent variable mean	-0.000	0.221	283.857
Dependent variable SD	1.000	2.194	231.105
Fund controls	✓	✓	
Bond controls			✓
Year-month FEs	✓	✓	
Issuer×Date FEs			✓
Rating FEs			✓

Table IA16
Shift-share analysis

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. Bond-level *Fund beta* is instrumented with shift-share *Fund beta*, which is estimated based on fund-level beta as of month $m-1$ and fund holdings as of month $m-13$. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	OLS	IV	
		First-stage	Second-stage
Dependent variable =	Yield spread	Fund beta	Yield spread
	(1)	(2)	(3)
Fund beta (shift-share)$_{b,m-1}$	25.790***	0.841***	
	(2.165)	(0.008)	
$\widehat{\text{Fund beta}}_{b,m-1}$			30.684***
			(2.545)
Ln(Par traded)$_{b,t}$	−14.421***	−0.001***	−14.402***
	(0.253)	(0.000)	(0.253)
Mutual fund holding$_{b,m-1}$	7.636***	0.007***	7.414***
	(0.700)	(0.001)	(0.696)
Ln(Offering amount)$_b$	−0.742	0.003***	−0.846
	(1.053)	(0.001)	(1.047)
Callable bond$_b$	−25.825***	−0.004**	−25.717***
	(2.155)	(0.001)	(2.156)
General obligation bond$_b$	−5.385	−0.005	−5.234
	(5.601)	(0.007)	(5.536)
Insured bond$_b$	17.512***	0.015***	17.059***
	(2.940)	(0.004)	(2.926)
Credit-enhanced bond$_b$	−6.781	−0.006	−6.611
	(8.529)	(0.010)	(8.429)
Bank-qualified bond$_b$	14.169	−0.028**	15.034
	(12.779)	(0.011)	(12.694)
Ln(Bond age)$_{b,t}$	−53.227***	−0.000	−53.223***
	(1.463)	(0.002)	(1.459)
Ln(Bond maturity)$_{b,t}$	26.191***	−0.000	26.193***
	(1.153)	(0.001)	(1.155)
Bond turnover$_{b,m-1}$	0.886***	−0.005***	1.051***
	(0.341)	(0.001)	(0.337)
N	14,514,798	14,514,798	14,514,798
Adjusted R^2	0.78	0.98	0.08
Weak identification F statistic			11,315.95
Issuer×Date FEs	✓	✓	✓
Rating FEs	✓	✓	✓

Table IA17
Primary market issuance cost: Shift-share analysis

This table reports results of regressions of a bond's offering yield spread on its issuer's fund beta:

$$\textit{Offering yield spread (bps)}_b = \alpha_{c,m} + \alpha_r + \beta \times \textit{Fund beta}_{i,m-1} + \eta' \mathbf{X}_b + \varepsilon_b,$$

where b indexes bonds, i issuers, c counties, r ratings, y years, and m year-months. Issuer-level *Fund beta* is the weighted average *fund beta* of the issuer's outstanding bonds as of the previous month, where the weight is determined by each bond's offering amount. *Fund beta* is instrumented with shift-share *Fund beta*, which is estimated based on fund-level beta as of month $m-1$ and fund holdings as of month $m-13$. The sample is limited to bond issues from issuers whose both *Fund beta* and shift-share *Fund beta* can be measured. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a bond. Standard errors are adjusted for clustering by state and year-month. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Fund beta	Yield spread		Tax-adjusted yield spread	
	First-stage	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)
Fund beta (shift-share)$_{i,m-1}$	0.692***	6.451***		10.620***	
	(0.034)	(1.184)		(2.093)	
$\widehat{\text{Fund beta}}_{i,m-1}$			9.328***		15.357***
			(1.690)		(2.955)
Mutual fund holding$_{i,m-1}$	0.011*	3.764***	3.665***	6.842***	6.680***
	(0.006)	(0.749)	(0.736)	(1.206)	(1.193)
Negotiated sale$_b$	−0.010	5.576***	5.672***	9.458***	9.616***
	(0.007)	(1.024)	(1.067)	(1.730)	(1.803)
Ln(Offering amount)$_b$	−0.001	−3.215***	−3.206***	−6.420***	−6.405***
	(0.001)	(0.436)	(0.436)	(0.663)	(0.662)
Callable bond$_b$	0.001	24.562***	24.557***	43.733***	43.726***
	(0.001)	(1.578)	(1.584)	(2.099)	(2.106)
General obligation bond$_b$	−0.017***	−1.158	−0.999	−1.341	−1.079
	(0.006)	(3.159)	(3.157)	(5.276)	(5.272)
Insured bond$_b$	0.009	1.144	1.063	1.020	0.888
	(0.008)	(2.347)	(2.372)	(4.238)	(4.281)
Credit-enhanced bond$_b$	0.001	0.751	0.746	1.236	1.227
	(0.008)	(1.330)	(1.321)	(2.171)	(2.169)
Bank-qualified bond$_b$	0.005	−9.522***	−9.567***	−17.382***	−17.457***
	(0.010)	(2.337)	(2.290)	(3.640)	(3.560)
Ln(Maturity)$_b$	0.000	11.254***	11.249***	59.074***	59.067***
	(0.000)	(1.932)	(1.933)	(4.226)	(4.226)
N	591,449	591,449	591,449	591,449	591,449
Adjusted R^2	0.99	0.82	0.38	0.86	0.71
Weak identification F statistic			405.13		405.13
Dependent variable mean	−0.000	30.550	30.550	202.178	202.178
Dependent variable SD	1.000	62.187	62.187	122.350	122.350
County×Year-month FEs	✓	✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓

Table IA18
County-level issuance amount: Shift-share analysis

This table reports results of regressions of a county's yearly issuance amount on its outstanding bonds' average fund beta:

$$Issuance\ amount_{c,y} = \alpha_{s,y} + \beta \times Fund\ beta_{c,y-1} + \eta'\mathbf{X}_{c,y} + \varepsilon_{c,y},$$

where c indexes counties, s states, and y years. County-level *Fund beta* is the weighted average *fund beta* of the county's outstanding bonds as of the previous year, where the weight is determined by each bond's offering amount. *Fund beta* is instrumented with shift-share *Fund beta*, which is estimated based on fund-level beta as of year $y-1$ and fund holdings as of year $y-2$. Yearly issuance amount is scaled by either the county's population or GDP, both measured from the previous year. The sample is limited to county-years whose both *Fund beta* and shift-share *Fund beta* can be measured. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a county-year. Standard errors are adjusted for clustering by state. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

Dependent variable =	Fund beta	Issuance amount per capita ($)		Issuance amount/GDP ($ per $1,000 GDP)	
	First-stage	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)
Fund beta (shift-share)$_{c,y-1}$	0.874***	−49.630***		−1.127***	
	(0.017)	(12.281)		(0.242)	
$\widehat{\text{Fund beta}}_{c,y-1}$			−56.802***		−1.289***
			(14.343)		(0.283)
Mutual fund holding$_{c,y-1}$	0.016***	40.100**	40.996**	0.810**	0.830**
	(0.003)	(17.126)	(17.222)	(0.313)	(0.315)
Ln(Outstanding debt)$_{c,y-1}$	−0.005	775.191***	774.888***	15.213***	15.206***
	(0.004)	(81.039)	(81.033)	(1.506)	(1.506)
Ln(GDP)$_{c,y-1}$	0.000	126.420	126.447	−12.419***	−12.419***
	(0.010)	(93.690)	(93.885)	(1.345)	(1.350)
Ln(Population)$_{c,y-1}$	0.006	−691.200***	−690.837***	0.100	0.108
	(0.008)	(99.866)	(99.970)	(1.037)	(1.040)
Ln(Average wage)$_{c,y-1}$	−0.008**	64.859**	64.409**	0.087	0.076
	(0.004)	(29.390)	(29.400)	(0.332)	(0.333)
Ln(House value)$_{c,y-1}$	0.005	15.721	15.985	0.234	0.240
	(0.003)	(31.425)	(31.417)	(0.476)	(0.477)
Unemployment rate$_{c,y-1}$	0.006	−26.620	−26.287	−0.470	−0.462
	(0.004)	(19.520)	(19.510)	(0.338)	(0.338)
Median age$_{c,y-1}$	0.003	−7.661	−7.505	−0.594**	−0.590**
	(0.002)	(18.412)	(18.416)	(0.253)	(0.253)
High school graduate$_{c,y-1}$	0.003	−22.769	−22.623	0.829**	0.832**
	(0.002)	(32.213)	(32.242)	(0.379)	(0.380)
N	22,693	22,693	22,693	22,693	22,693
Adjusted R^2	0.95	0.29	0.25	0.23	0.18
Weak identification F statistic			2,709.92		2,709.92
Dependent variable mean	0.000	532.818	532.818	12.103	12.103
Dependent variable SD	1.000	879.840	879.840	17.800	17.800
State×Year FEs	✓	✓	✓	✓	✓

Table IA19
Robustness

This table shows the robustness of the results in column 1 of Table 2 and column 3 of Table 3. In row (2), issuers are identified using Mergent's *issuer_long_name*. Rows (3)–(5) include different sets of fixed effects. Rows (6)–(8) use weighted least square regressions, with the weight being the across-fund par-weighted average R^2, or the absolute value of the t-statistic of the beta estimate (from Equation 1 in Section 2.1), or the bond's mutual fund holding. Row (9) uses "sum of betas" measures, estimated from the regressions of fund return on contemporaneous and three lags of market returns. Rows (10)–(11) use either the trading yield or the yield spread, not adjusted for taxes, as the dependent variable. Rows (12)–(14) control for the bond's Amihud, holding funds' average 12-month return, or flow pressure. Rows (15)–(20) split the sample into small and large trades (using the $100,000 par amount cutoff), or based on mutual fund ownership, or based on aggregate net outflows. Rows (21) excludes the first half of 2020. Rows (22) uses the subsample with non-missing bond beta. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

		Main explanatory variable		
	N	Fund beta	Direct fund beta	Indirect fund beta
(1) Baseline	18,012,021	25.338***	17.213***	−4.603**
		(2.082)	(0.947)	(2.005)
(2) Mergent-based issuer identification	18,011,997	27.746***	17.896***	−1.865
		(1.960)	(0.923)	(2.032)
(3) Rating and date FEs	18,012,021	40.931***	24.951***	−3.484
		(1.674)	(0.802)	(2.257)
(4) Issuer-date, rating, and dealer-date FEs (2007–2017)	12,771,031	30.696***	15.502***	10.292***
		(2.036)	(0.901)	(2.302)
(5) Bond, rating, and date FEs	18,006,826	7.899***	2.612***	7.897***
		(1.457)	(0.663)	(1.680)
(6) Weighted by R-squared	18,012,021	27.139***	17.354***	−4.157**
		(1.988)	(0.969)	(2.000)
(7) Weighted by absolute value of t-stat	18,012,021	27.189***	17.763***	−3.796*
		(2.055)	(0.963)	(2.007)
(8) Weighted by mutual fund holding	18,012,021	28.065***	19.942***	−7.802***
		(2.469)	(1.122)	(2.134)
(9) Sum of betas	18,012,021	9.098***	16.598***	−24.325***
		(1.771)	(1.031)	(1.393)
(10) Bond yield	18,012,021	21.163***	11.033***	7.606***
		(1.210)	(0.537)	(1.497)
(11) Yield spread, not tax-adjusted	18,012,021	12.172***	9.980***	−8.071***
		(1.281)	(0.588)	(1.081)
(12) Controlling for lagged Amihud	13,081,428	25.508***	17.131***	−3.626
		(2.562)	(1.170)	(2.348)
(13) Controlling for fund return	18,012,021	26.377***	18.184***	−4.622**
		(2.127)	(0.991)	(1.932)
(14) Controlling for fund return & flow pressure	17,987,982	26.162***	18.171***	−5.106***
		(2.122)	(0.990)	(1.915)
(15) Small trades	13,640,638	24.461***	16.365***	−5.107**
		(2.044)	(0.910)	(1.998)
(16) Large trades	3,658,260	25.666***	18.305***	−3.139
		(2.914)	(1.462)	(2.350)
(17) High mutual fund ownership	8,676,950	28.462***	20.591***	−8.884***
		(2.973)	(1.317)	(2.564)
(18) Low mutual fund ownership	8,697,742	19.491***	12.992***	−1.836
		(1.945)	(0.913)	(2.269)
(19) Positive aggregate net outflows	6,273,404	21.931***	15.190***	−9.426***
		(2.064)	(0.851)	(3.043)
(20) Negative aggregate net outflows	11,738,617	27.327***	18.062***	−1.378
		(2.323)	(1.071)	(2.215)
(21) Excluding COVID period	17,279,048	25.434***	17.234***	−4.392**
		(2.099)	(0.958)	(2.011)
(22) Subsample with non-missing bond beta	9,851,113	29.611***	19.427***	−2.180
		(2.868)	(1.336)	(2.564)

Table IA20
Mutual fund ownership and fund return

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with holding funds' average return and the bond's mutual fund ownership:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Fund return (holding)}_{b,m-1} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. *Fund return* is the par-weighted average of the holding funds' 12-month average returns. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)
Fund beta$_{b,m-1}$	26.954***	26.368***	26.945***
	(2.157)	(2.110)	(2.139)
Fund beta$_{b,m-1}\times$ Fund return$_{b,m-12\to m-1}$	−1.970***		−1.971***
	(0.351)		(0.347)
Fund beta$_{b,m-1}\times$ Mutual fund holding$_{b,m-1}$		2.434***	2.436***
		(0.551)	(0.532)
Fund return$_{b,m-12\to m-1}$	9.942***	5.173***	9.915***
	(1.576)	(1.178)	(1.575)
Mutual fund holding$_{b,m-1}$	6.521***	6.647***	6.572***
	(0.616)	(0.617)	(0.614)
N	18,012,021	18,012,021	18,012,021
Adjusted R^2	0.77	0.77	0.77
Bond controls	✓	✓	✓
Issuer×Date FEs	✓	✓	✓
Rating FEs	✓	✓	✓

Table IA21
Bond characteristics

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with bond characteristics:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Bond characteristics}_{b,t} + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fund beta$_{b,m-1}$	15.488***	28.619***	25.578***	19.216***	0.317	5.847***	8.099***	−1.152
	(1.715)	(1.883)	(2.077)	(1.596)	(1.349)	(1.320)	(1.444)	(1.226)
Fund beta$_{b,m-1}$× Bond rating$_{b,t}$	10.575***			10.777***	6.526***			6.356***
	(1.188)			(1.199)	(0.595)			(0.584)
Fund beta$_{b,m-1}$× Ln(Bond maturity)$_{b,t}$		−4.560***		−5.071***		2.119***		1.796***
		(0.802)		(0.736)		(0.650)		(0.622)
Fund beta$_{b,m-1}$× Bond turnover$_{b,m-1}$			−2.079***	−1.117***			−1.595***	−1.263***
			(0.250)	(0.235)			(0.184)	(0.186)
Ln(Bond maturity)$_{b,t}$	29.188***	27.485***	28.050***	28.538***	−69.812***	−66.594***	−66.896***	−69.458***
	(1.083)	(1.081)	(1.070)	(1.093)	(1.332)	(1.344)	(1.327)	(1.349)
Bond turnover$_{b,m-1}$	2.118***	1.439***	1.391***	2.046***	−1.626***	−1.613***	−1.506***	−1.548***
	(0.232)	(0.241)	(0.240)	(0.232)	(0.234)	(0.229)	(0.223)	(0.231)
N	16,862,675	18,012,021	18,012,021	16,862,675	16,893,436	18,006,826	18,006,826	16,893,436
Adjusted R^2	0.78	0.77	0.77	0.78	0.77	0.77	0.77	0.77
Bond controls	✓	✓	✓	✓	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓				
Bond FEs					✓	✓	✓	✓
Date FEs					✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓	✓	✓

Table IA22
Market conditions

This table reports results of regressions of a bond's tax-adjusted yield spread on the average beta of its holding funds interacted with market condition measures:

$$\textit{Yield spread (bps)}_{b,t} = \alpha_{i,t} + \alpha_r + \beta \times \textit{Fund beta}_{b,m-1} \times \textit{Market condition}_t + \eta' \mathbf{X}_{b,t} + \varepsilon_{b,t},$$

where b indexes bonds, i issuers, r ratings, and m year-months, and t trading days. All market condition measures are as of day t: 1) the average market markup on customer trades; 2) the aggregate net outflows open-end municipal bond funds; and 3) VIX. In columns 3–4 and 7–8, the sample period is 2009–2021 due to the availability of daily flow data. All continuous explanatory variables are standardized to have a mean of zero and a standard deviation of one. The unit of observation is a transaction. Standard errors are adjusted for clustering by bond and trading day. $*$, $**$, and $***$ indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fund beta$_{b,m-1}$	14.205***	21.152***	23.285***	13.931***	4.304***	6.749***	3.800***	4.626***
	(1.667)	(2.105)	(2.313)	(1.849)	(1.404)	(1.580)	(1.259)	(1.251)
Fund beta$_{b,m-1}\times$ Market markup$_t$	18.718***			21.311***	4.844***			−2.504***
	(1.425)			(2.087)	(0.822)			(0.684)
Fund beta$_{b,m-1}\times$ VIX$_t$		7.186***		6.357***		1.632***		1.783**
		(0.855)		(1.725)		(0.550)		(0.907)
Fund beta$_{b,m-1}\times$ Aggregate net outflows$_t$			−7.844***	−3.221*			3.586***	3.406***
			(1.971)	(1.676)			(1.091)	(1.065)
N	18,012,021	18,012,021	16,028,212	16,028,212	18,006,826	18,006,826	16,023,394	16,023,394
Adjusted R^2	0.77	0.77	0.77	0.77	0.77	0.77	0.79	0.79
Bond controls	✓	✓	✓	✓	✓	✓	✓	✓
Issuer×Date FEs	✓	✓	✓	✓				
Bond FEs					✓	✓	✓	✓
Date FEs					✓	✓	✓	✓
Rating FEs	✓	✓	✓	✓	✓	✓	✓	✓