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Abstract

We examine the role of institutional investors in monetary policy transmission to asset markets by exploiting a discontinuous threshold in the tax treatment of municipal bonds. As bonds approach the threshold, mutual funds, the primary institutional traders in the market, dispose of the bonds at significant risk of falling below the threshold. This is driven by mutual funds anticipating future illiquidity. Once bonds cross the threshold, their liquidity declines and illiquidity-induced yield spreads increase substantially as retail investors become more important in price formation. Unexpected monetary policy tightening sharply reduces trading activity, amplifying the path to illiquidity in the market.

Keywords: Monetary Policy, Municipal Bonds, Institutional Investors, Asset Liquidity

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1 Introduction

A large literature in finance studies the impact of monetary policy on different asset classes such as equities, treasury securities, and corporate bonds (Bernanke and Kuttner, 2005; Pastor and Veronesi, 2012; Swanson, 2021; Guo, Kontonikas and Maio, 2020; Albagli, Ceballos, Claro and Romero, 2019; Kuttner, 2001). While monetary policy transmission to asset prices has been studied extensively, we know little about the role of institutional investors in such transmission. Recent research shows that institutional investors are essential in price formation,[1] implying they are also likely to have outsize importance for monetary policy transmission to asset markets and the broader economy. Notably, monetary policy transmission through this "institutional investor channel" may amplify financial market fragility akin to mutual funds propagating aggregate demand shocks in equities and bonds (Falato, Hortacsu, Li and Shin, 2021; Li, O'Hara and Zhou, 2022; Ben-David, Li, Rossi and Song, 2022).

In this paper we shed light on the role of institutional investors in price formation and on how monetary policy transmits through institutional investors to prices in the context of the $4 trillion municipal bond market. The municipal bond market provides a natural setting to study this question because both retail traders and institutions hold large shares of outstanding bonds. This allows us to examine how changes in ownership translate to changes in bond pricing and liquidity. We exploit the discontinuous tax treatment of investment proceeds to show that the exit of mutual funds from the secondary market leads to significantly lower liquidity—an important feature of this market even in "normal" economic times. Then using innovations in fed funds rates and measures of monetary policy surprises from Bauer and Swanson (2022), we show that (unexpected) policy tightening amplifies funds' disposition of bonds at risk of adverse tax treatment and speeds up the path to illiquidity in this market.

While interest payments from tax-exempt municipal bonds are typically exempt from federal and state income taxation, realized price appreciation is not. Since 1993 investors who purchase

[1] See, for example, He and Krishnamurthy (2013); He, Kelly and Manela (2017); Koijen and Yogo (2019); Gabaix and Koijen (2021); Ben-David, Franzoni, Moussawi and Sedunov (2021); Vayanos and Vila (2021).

municipal bonds below a "de minimis" threshold are responsible for ordinary income taxes on any realized price appreciation.[2] This threshold is determined by the bonds' original issue price, the number of years since issuance, and the number of full remaining years to maturity. For municipal bond investors, typically in the highest income tax brackets, acquiring bonds at prices below the "de minimis" threshold can easily lead to the doubling of tax liability on future realized price appreciation. We show that this discrete tax hike leads to selling pressure and illiquidity in the municipal bond market.

We study bond trading dynamics around the de minimis threshold using the evenly spaced partitioning estimators of Calonico, Cattaneo and Titiunik (2015) and relying on transaction-level data from 2010 through 2022. Given the well defined nature of the de minimis price for each bond, many investors, anticipating few potential buyers and low liquidity below the threshold, have incentives to dispose of bonds in the immediate vicinity above the threshold. We test this idea using secondary market data on customer-to-dealer sales transactions and show that the dollar volume of sales increases significantly as bonds approach the threshold from above. Immediately above the cutoff the average weekly sales volume for the typical municipal bond increases from about $200 thousand to over $450 thousand. The large increase in trading activity is driven by a significant increase in average trade size, which nearly doubles to about $300 thousand as bonds get close to the de minimis price.

The incidence of trading activity drops sharply after bonds fall below the cutoff, suggesting a reduction in secondary market liquidity. Conditional on the presence of trading, average trade size plummets, while the number of trades increases. Thus, total weekly par amount traded recovers to above-threshold levels but retail investors become a significantly larger share of secondary market activity. These findings are suggestive of retail and institutional investors each increasing their presence in different portions of the price distribution around the de minimis threshold.[3]

The large increase in trade size immediately above the threshold points to institutional investors

[2] Realized price appreciation from bonds purchased above this threshold but below par incurs capital gains taxes.

[3] We consider "large" trades, those exceeding $100,000 in total par dollar amount, as institutional and "small" trades, those below $25,000 in total par dollar amount, as retail.

dominating secondary market trading. Using data on quarterly institutional investor holdings, we find that mutual funds—the group of investors that accounts for the bulk of institutional municipal bond holdings—dispose of significant portion of their exposure to bonds approaching the threshold. The selling patterns are highly dependent on bond duration, or the sensitivity of bonds to interest rate risk. Mutual funds sell less interest rate-sensitive, low-duration, bonds in the immediate vicinity of the de minimis threshold, but dispose of higher-duration bonds well above the threshold. These disposition patterns minimize the risk that these investors find themselves below the de minimis threshold due to unexpected increases in interest rates.

We corroborate this idea by examining the trading activity of funds following a duration-based strategy. We differentiate between funds that target short-, intermediate-, or long-duration portfolios, and show that duration targets are predictive of the onset of fund dispositions of municipal bonds near the de minimis threshold. We also examine how the heterogeneity of mutual fund strategies translates to differences in trading activity. We show that municipal bond funds and funds with an explicit tax exemption investment objective are more likely to dispose of municipal bonds above the threshold than funds with more diversified portfolios. Finally, funds with high flow volatility—those with above-median asset growth variance—are more likely to sell bonds at risk of falling below the threshold.

De minimis risk appears to be tightly linked to monetary policy—it increases in a rising interest rate environment as higher rates push bonds closer to or below the threshold. During a period of monetary tightening, the bonds underlying as much as a quarter of all secondary market transactions face significant probability of falling below the threshold (carry de minimis risk). Weekly increases in the federal funds rate are strongly positively correlated with contemporaneous institutional sales volume above the threshold, amplifying the path to illiquidity documented earlier. Specifically, institutional sales volume increases immediately above the threshold for the most interest rate-sensitive bonds and over a wider range of prices above the threshold for less sensitive bonds. These results are consistent with investors disposing of high-duration bonds well in advance of rate increases, generating a limited response to contemporaneous rate hikes. Increases in policy rates over longer than weekly horizons translate to additional institutional dispositions further away from the threshold but these effects are muted relative to the contemporaneous effects. Finally, we show that in weeks with positive monetary policy surprises, bonds immediately above the threshold exhibit further increases in institutional sales volume of roughly three percentage points relative to bonds further away from the threshold and non-FOMC bond-weeks.

We also find large increases in trading costs around the de minimis threshold. The average mark-ups of customer prices relative to inter-dealer prices are significantly larger below than above the threshold among all trade sizes. Despite the consistently low markups among large trades in line with prior literature (Green, Hollifield, and Schürhoff, 2007; Schultz, 2012; Griffin, Hirschey and Kruger, 2022), we document increases in selling pressure above the de minimis threshold coming from large transactions. Selling pressure, defined as the price differential between contemporaneous large and small sales transactions (see Feldhütter (2012)), increases as mutual funds specializing in municipal bonds exit their positions in bonds approaching the de minimis threshold.

We extend the literature studying the role of taxes in municipal bond pricing (Green, 1993; Wang, Wu and Zhang, 2008; Cestau, Hollifield, Li and Schürhoff, 2019; Ang, Bhansali and Xing, 2014) by showing that tax-induced investor segmentation is a key determinant of bond prices. The study closest to ours, Ang, Bhansali and Xing (2010), provides model-free estimates of implicit tax rates perceived by market participants by comparing yields of bonds below the de minimis threshold to those of premium-coupon bonds. The authors estimate implied ordinary income tax rates of 70-100% below the threshold, even for dealer trades. This is puzzling because ordinary income tax rates during their sample period never exceeded 40% and because intermediaries are typically not subject to ordinary income taxes.[4] Our paper sheds light on this puzzle by showing that the increase in yields is largely driven by investor segmentation-induced illiquidity below the de minimis threshold. Conducting a similar exercise to that in Ang, Bhansali and Xing (2010), we show that the yield differential of below-de minimis bonds is substantially higher for municipal

[4] Longstaff (2011) also estimates implied income tax rates from municipal yields and arrives at a range of 8%-55%. His sample, however, comprises of variable rate demand obligations (VRDOs), which have significantly shorter effective maturities and different investor base than the typical municipal bond.

bonds that recently lost a significant portion of their mutual fund investor base or that are otherwise less liquid. More broadly, our paper suggests the interaction of fiscal and monetary policy may have large unintended consequences on asset liquidity and pricing in asset markets.

We also contribute to the recent literature studying asset prices in terms of demand for directly observed asset characteristics, instead of traditional risk-based portfolio choice. Koijen and Yogo (2019) estimate an asset demand system where heterogeneous demand elasticities across investors affect price dynamics in equity markets, while Bretscher, Schmid, Sen and Sharma (2020) apply a similar demand system estimation to the corporate bond market. A central theme in this literature is the existence of significant frictions that prevent assets from being priced solely as in classical theory (Merton, 1973; Lucas, 1976). We show that institutional demand for observed asset characteristics is important not only for asset prices, but also for asset liquidity. We also document that monetary policy can amplify the impact of institutional demand on asset illiquidity and prices.

Finally, we extend the recent literature on the growing importance of mutual funds in over-the-counter markets. While some of this literature shows that mutual funds may increase the fragility of bond markets in a time of stress (Falato, Hortacsu, Li and Shin, 2021; Li, O'Hara and Zhou, 2022), other work establishes the beneficial impact of mutual funds in bond markets. For example, Adelino, Cheong, Choi and Oh (2021) shows that relationships between issuers and mutual funds improves issuers' capital acquisition prospects whenever funds face unexpected inflows. Combining their result with our findings on investor segmentation implies that the ability of issuers to raise financing in a contractionary monetary policy environment may be impaired.

We also complement Chernenko and Doan (2020), Chernenko and Doan (2022), and Giannetti and Jotikasthira (2022), which show that mutual funds are central in creating and maintaining liquidity in the municipal bond market. The Municipal Securities Rulemaking Board (MSRB), one of the primary regulators of the municipal bond market, also highlights the increased importance of mutual funds for municipal bonds.[5] We find that mutual funds exit makes large swaths of the municipal bond market illiquid during episodes of contractionary monetary policy.

[5] https://www.msrb.org/Press-Releases/MSRB-Research-Reveals-Significant-Shifts-Municipal-Securities-Ownership

2 Institutional Background

While interest on tax-exempt municipal bonds in the United States is typically exempt from income taxes, realized price appreciation may, however, be subject to income taxes. This happens when investors purchase the bond in the secondary market at a discount from its original face value at issuance. The Internal Revenue Service (IRS) treats any realized price appreciation in excess of a "de minimis" amount as ordinary income, while realized price appreciation less than the "de minimis" amount as capital gains. The de minimis amount is equal to 0.25% $\times$ the complete years remaining to maturity $\times$ the bond's par value. For example, the maximum discount taxable at capital gains rates on a tax-exempt bond issued at par with 10 full years to maturity and a par value of \$100 is equal to 10 $\times$ 0.25% $\times$ \$100, or \$2.5. Therefore, a purchase price below \$97.5 means that the buyer owes ordinary income taxes if in the future she sells or redeems the bond at prices above \$97.5. This bond is typically referred to as a "market discount" bond. A purchase price above \$97.5 but below \$100 implies capital gains taxation. Finally, the proceeds from tax-exempt bonds purchased at par or at a premium to par are tax-free.[6]

The current tax regime has been in place since May 1st 1993, when the Omnibus Budget Reconciliation Act (OBRA) of 1993 repealed the exemption of realized price appreciation on municipal bonds from ordinary income taxes under Section 1276 of the Internal Revenue Code.[7] Previously, market discount municipal bonds would only trigger capital gains taxes. Repealing the exemption of municipal bond proceeds was not among the major goals or provisions of the bill and was not expected to raise substantial government revenue as it was not listed in any of the estimates of the Congressional Budget Office (CBO) or the Joint Committee on Taxation (JCT).[8] Instead, OBRA's major provisions were expected to reduce the federal deficit by an estimated \$387 billion primarily through lowering individual income tax brackets, increasing corporate income tax rates, and decreasing direct and discretionary spending.

[6] For additional details, see https://www.fidelity.com/bin-public/060_www_fidelity_com/documents/fixed-income/deminimis-dilemma-Fidelity.pdf.

[7] https://www.congress.gov/103/statute/STATUTE-107/STATUTE-107-Pg312.pdf

[8] See https://www.cbo.gov/sites/default/files/103rd-congress-1993-1994/reports/09-1993-outlookentirerpt_0.pdf and https://www.jct.gov/CMSPages/GetFile.aspx?guid=fb4f267b-422d-40c8-b751-c7737316f28e

Given the municipal bond market is dominated by tax-sensitive retail investors, these investors may have incentives to avoid municipal bonds that are either below or just above the de minimis threshold. Price appreciation on bonds purchased just above the threshold is not subject to ordinary income taxes but additional market volatility or interest rates increases may push these bonds below the threshold, where there may be few potential buyers. This is because the adverse tax consequences associated with falling below the de minimis price are likely to reduce investor demand. For example, tax-sensitive investors are a lot less likely to purchase market discount bonds than par or premium bonds.

Concerns about tax consequences of market discount bonds naturally increase with market volatility and in rising interest rate environments. For example, when interest rates were set to increase in 2006, 2013, and 2017 "de minimis fears" increased as well.[9] Inflationary pressures have recently sparked similar fears in the municipal bond market. In light of the lower sophistication of retail investors that dominate this market, both regulators and investment advisers have recently issued statements warning investors about de minimis risk.[10]

3 Data

3.1 Data Description and Summary Statistics

To gain insight into trading activity around the de minimis threshold we use secondary market pricing data on municipal bonds since 2010 provided with permission by the Municipal Securities Rulemaking Board (MSRB). For the purposes of the analysis, we limit the sample to bonds with fixed coupons and zero coupon bonds. As our study focuses on secondary market outcomes, we exclude trades that occur before the settlement date or within sixty days of primary offerings, as well as transactions by the underwriters of the offerings. We also exclude observations where the transaction price or amount are missing or not verified by the MSRB, the transaction price is based

[9] See https://www.bondbuyer.com/news/why-de-minimis-risk-is-a-topic-again.

[10] See https://msrb.org/-/media/Files/Resources/Tax-and-Liquidity-Considerations-for-Buying-Discount-Bonds.ashx or https://www.pimco.com/en-us/resources/education/understanding-the-de-minimis-tax-rule/

on multiple transactions, customers and dealers use non-transaction-based compensation, or bond yields are negative. Finally, to mitigate the effect of outliers and data errors, we trim trade prices and yields at the 0.5^{th} and the 99.5^{th} percentiles.

We obtain the universe of municipal bond issues from the Mergent Municipal Bond Securities Database (Mergent). Mergent identifies municipal issuers as well as a wide range of issuance characteristics both at the issue and the bond series level. These include offering amount, type, maturities, the presence of bond insurance, and yields. We exclude issues where the bond coupon rate or maturity do not equal to the corresponding coupon and maturity values from the EMMA data set. We also exclude all transactions that occur after the maturity date of a given bond. This results in a sample of 92,017,724 transactions by 45,428 unique issuers (in terms of the 6-digit CUSIP) since October 2010. Because most municipal bonds are illiquid, bonds that trade frequently are likely to have a disproportionate impact on our results. To mitigate such concerns we collapse the data to the week-bond CUSIP level by computing the total dollar volume, the number of trades, and the par-weighted average price per trade for each CUSIP in a given week, resulting in 25,269,697 CUSIP-weeks. Finally, we exclude the highly volatile COVID-19 pandemic period (2020w6-2021w12), which initially led to drying up of secondary market activity with this trend reversing following the multiple rounds of government stimulus (Haughwout, Hyman and Shachar, 2022; Ivanov, Zimmermann and Heinrich, 2022). Our final sample has 22,871,452 CUSIP-weeks.

To shed light on the economic mechanisms behind municipal bond illiquidity, we use quarter-end portfolio holdings of institutional investors from eMaxx from Thomson Reuters since the first quarter of 2010. eMaxx provides security-level data on asset holdings of a wide range of institutional investors. We subset the data to US mutual funds and life insurers. In our main specifications we limit the sample to US mutual funds because investor proceeds from these funds have the same tax treatment as direct proceeds from municipal bonds. We also examine trading by life insurance companies for comparison purposes because their long investment horizons resemble a buy-and-hold investment strategy. Merging the holdings data with municipal bonds information from Mergent results in a sample of 335,036 different municipal bonds held by 3,357 mutual funds and 1,550 life insurance companies. At the end of 2021, mutual funds held about $960 billion of outstanding municipal bonds, while life insurance companies held roughly $168 billion. We classify 1,523 funds as "municipal bond funds", with over 90 percent of their assets invested in municipal securities. As of the end of 2021, these funds account for 97 percent of the municipal bond holdings of all mutual funds in our sample.

In most of our analysis, we limit the sample to customer-to-dealer sales transactions in bonds where interest is exempt from income taxes as we study the role of expected liquidity on sellers' portfolio choices. Table 1 shows that, conditional on at least one sale transaction, the size of the average transaction in a typical week is roughly $240 thousand. We define small, medium, or large trades as those below $25,000, between $25,000 and $100,000, or exceeding $100,000 in terms of transaction par value, respectively. The municipal bond market literature attributes small trades to retail investors, while large trades to institutional investors (Schultz, 2012; Cornaggia, Hund and Nguyen, 2020; Chalmers, Liu and Wang, 2021). Consistent with this idea, large trades exceed $800 thousands, while the average small trade amounts to only about $14 thousand in par value. Trading activity in terms of trades count is fairly low in a typical bond-week with only 1.29 sales transactions.[11] Such low trading activity is a distinguishing characteristic of the municipal bond market. Finally, consistent with more favorable dealer execution of institutional transactions, transaction yields are substantially lower for large than for small trades.

We calculate yield spreads of bonds around the de minimis threshold relative to the hypothetical yields of above-par bonds computed from zero rates based on the Svensson extension of the Nelson-Siegel (NSS) model (Nelson and Siegel, 1987; Svensson, 1994). We utilize the NSS model because the Nelson-Siegel zero curve has difficulty matching yields at long maturities. We calculate yield spreads for small, medium, and large trades, separately.[12] Intuitively, Table 1 shows that yield spreads within 10 percentage points of the de minimis threshold are substantially larger for small trades at 2.83% than for large trades at 2.07%.

[11]Summing observation count across small, medium, and large trades exceeds the number of observations for combined sales volume, number of trades, and yields because a given bond-week may have trades in multiple trade sizes.

[12]See Appendix B for detailed description on the yield spreads construction.

To understand the relation between monetary policy and municipal bond liquidity, we use Federal Funds effective rate data provided by the Board of Governors of the Federal Reserve System to create one-, four-, eight-, and twelve-week changes in the fed funds rate through November of 2022. We also rely on data on monetary policy surprises from 1988 to 2019 provided by Michael Bauer and Eric Swanson. The first measure of monetary policy surprises, MPS, is the first principal component of changes in the current quarter as well as one-, two-, and three-quarters ahead Eurodollar futures contracts around FOMC announcements, rescaled so that the a one-unit change in the MPS measure corresponds to a one percentage change in the three-quarters ahead futures contract. The second monetary policy surprises measure, MPS_{ORTH}, orthogonalizes MPS with respect to key macro and financial factors (Bauer and Jayawickrema, 2021; Bauer and Swanson, 2022). Table 1 shows that the average fed funds rate is only 66 basis points with small and positive average rate changes as most of our sample period is characterized by low interest rates. Monetary policy surprises are positive in about 6-7% of the bond-weeks and negative in about 6-8% of bond-weeks. The roughly equal probability of positive and negative surprises is consistent with the monetary policy surprise measure picking up unexpected, or more exogenous, revisions in monetary policy.

3.2 Defining the De Minimis Price Threshold

We follow IRS publication 1212 to arrive at the de minimis price for each bond.[13] The price threshold, below which bond appreciation is subject to ordinary income taxes, is a function of a bond's adjusted offering price, P_t^o, and the de minimis amount. P_t^o is computed as follows:

$$
\begin{aligned}
P_t^o &= P_{t-1}^o + A_t, \\
A_t &= (P_{t-1}^o \times R) - C \\
P_{t=0}^o &\equiv P^o
\end{aligned}
\tag{1}
$$

where the bond's adjusted offering price within the first year of the offering, $P_{t=0}^o$, is simply the

[13] https://www.irs.gov/pub/irs-pdf/p1212.pdf

bond's offering price, P^o. A_t is the accretion to the adjusted offering price in year t following the offering, R is the offering yield in percent, and C is the bond's coupon in dollar terms. t is rounded up to the next full year since the offering. The de minimis price, P^d, is then defined as follows:

$$P^d = \begin{cases} 100 - \lfloor T-t \rfloor \times 0.25 & \text{if } P^o \geq 100, \\ P_t^o - \lfloor T-t \rfloor \times 0.25 & \text{if } P^o < 100 \end{cases} \tag{2}$$

where T is the bond's contractual maturity (in years) and $\lfloor T-t \rfloor$ is the number of full remaining years to maturity of the bond. This equation simply says that for par or premium coupon bonds, P^d is the difference between par value and the full remaining years to maturity multiplied by 0.25. The computation is slightly different for original issue discount (OID) bonds where we have the adjusted offering price instead of par value.

We compute the distance to the de minimis price, Δ, sequentially in terms of customer purchase, customer sales, and dealer prices because a bond's tax treatment is determined by its purchase price. We define Δ as the difference between the minimum customer purchase price and the de minimis price in a given CUSIP-week, whenever purchase prices are available. If no purchase prices are available but sale prices are, we define Δ as the difference between the minimum sale price and the de minimis price. If only dealer prices are available, we define Δ as the difference between the par-weighted average across dealer prices and the de minimis price. Table 1 shows that the average bond-week is about 10 percentage points above de minimis. Roughly a quarter of bond-weeks is close to de minimis with a distance of 4 percentage points or less.

4 Empirical Design

4.1 The Evolution of Bond Liquidity around the Cutoff

We study the evolution of municipal bond trading activity around the de minimis threshold using the evenly spaced partitioning (ES) estimators of Calonico, Cattaneo and Titiunik (2015). These estimators provide a convenient non-parametric representation of the raw data in light of the substantial variability and the large number of municipal bond transactions. The ES estimators present local means of the distribution of a given variable, x, by partitioning the data as follows:

$$p_{-,j} = x_l + j \times \frac{\bar{x} - x_l}{J_{-,n}} \quad and \quad p_{+,j} = \bar{x} + j \times \frac{x_u - \bar{x}}{J_{+,n}} \tag{3}$$

where $p_{-,j}$ and $p_{+,j}$ are the jth bin on left and the right of the cutoff, x_l and x_u are the upper and lower bounds of the support of x, $\bar{x}$ is the value of the cutoff, and $J_{-,n}$ and $J_{+,n}$ are the number of bins below and above the cutoff, respectively.

$J_{-,n}$ and $J_{+,n}$, are determined according to an integrated mean square error (IMSE) loss function that trades off bias and variability of the partitioning estimators. For example, allowing for too many bins reduces the bias of the local mean estimates but increases their variability. The ES estimator spaces the underlying data on each side of the cutoff in equal intervals and arrives at the number of bins on each side using an IMSE loss function that gives variance and bias equal weights. In robustness tests, we explore alternative approaches that account for the sparsity of the data using quantile approaches or polynomial regressions approximations of the means in each equally spaced bin, which better addresses noncontinuous outcomes. We find very similar results in all of these cases (see Appendix Figures C.1 and C.2).

We apply the ES estimator to the weekly CUSIP data to understand the evolution of municipal trading activity around the de minimis threshold. We examine four main measures of trading activity—the incidence of trading, the number of trades, the total par value traded, and the average par value per trade—for each bond-week in the sample. In these tests we limit the sample to bonds within 4 percentage points from the de minimis threshold (expressed in percentage points of par value) as we are interested in secondary market liquidity dynamics close to the cutoff. This results in a sample of 4,329,938 and 486,244 bond-weeks of tax-exempt and taxable bonds, respectively, or over a fifth of all bond-weeks in the data.

We expect secondary-market activity in municipal bonds to decline after crossing the threshold because of the high tax sensitivity of municipal bond investors. Realized price appreciation from bonds purchased at prices below the threshold is subject to ordinary income taxes as compared to capital gains taxes for purchases above the threshold. Ordinary income is typically taxed at substantially higher rates than capital gains for most municipal bond investors. For example, over 75% of outstanding municipal bonds are held directly or indirectly in mutual funds by retail investors in the high-tax brackets of household income (Feenberg and Poterba, 1991; Poterba and Samwick, 2003; MSRB, 2020). In line with the high tax sensitivity of retail investors, municipal bond mutual funds are unlikely to purchase bonds below threshold. Many funds have formal investment objective that rule out such purchases. For example, PIMCO states that their municipal bond funds "seek high income exempt from federal taxes [...] where capital appreciation is a secondary objective" and that funds provide tax-exempt income while "preserving liquidity."[14]

Overall, falling below the de minimis threshold is likely to be associated with a reduction in investor demand and, consequently, lower secondary market activity. Such decline is likely to be more pronounced for tax-exempt than for taxable bonds as the former are typically held by tax-sensitive investors, while the latter tend to be held by less tax-sensitive clienteles such as foreign investors, pension funds, IRAs, 401(k)s, and endowments (Hernandez Barcena and Wessel, 2020). Therefore, in most of the analysis we focus on the sub-sample of tax-exempt bonds.

Investors may anticipate the lower secondary market demand below the threshold and may preemptively sell bonds before crossing the threshold. Actively-managed institutional investors such as mutual funds are more likely to engage in such anticipatory dispositions because of shorter investment horizons and fire sales risk as compared to buy-and-hold investors such as individuals and insurance companies. For example, prior literature documents significant fire-sale externalities in the mutual fund industry (Coval and Stafford, 2007; Falato, Hortacsu, Li and Shin, 2021) and preemptive dispositions of holdings that are most prone to fire sales risk (Chernenko and Doan, 2020; Giannetti and Jotikasthira, 2022). Consistent with such anticipatory sales, the Bond Buyer reports that due to de minimis risk "institutional investors purchase bonds at big premiums" and

[14] https://www.pimco.com/en-us/investments/mutual-funds/municipal-bond-fund/inst

that some mutual funds "have an informal protocols of bailing out and selling once a bond moves down to 103."[15] To the extent that municipal bond investors increase dispositions before the cutoff and these empirical patterns are driven by institutional investors, the dollar volume of traded bonds and trade size are likely to increase substantially before bonds hit the cutoff.

4.2 Mutual Fund Trading Activity

We next examine the disposition activity of mutual funds as municipal bonds approach the de minimis threshold. In the first set of these test we compare selling patterns of mutual funds to those of life insurance companies, which tend to be buy-and-hold investors less affected by liquidity considerations:

$$Sell_{bft} = \sum_{i<-4}^{+4} \beta_i \, MF_f \times Distance_{ibft} + \gamma X_{bft} + \varepsilon_{bft} \tag{4}$$

$Sell_{bft}$ takes the value of one whenever asset manager f is a net seller of bond b in terms of dollar volume between quarters $t-1$ and t, and zero otherwise. MF_f takes the value of one whenever asset manager f is a mutual fund, and zero if a life insurer. $Distance_{ibft}$ takes the value of one whenever the average distance of the secondary market price of bond b to the de minimis threshold held by fund f in quarter t is in interval i. i includes < -4, -4, -3, ..., $+4$, corresponding to the < -4, $[-4,-3)$, $[-3,-2)$, ..., $[+3,+4]$ intervals measuring distance from the de minimis threshold in percentage points of par value. The omitted group in the regressions includes bonds at least 4 percentage points above the de minimis price. The matrix X comprises of bond-, fund-, and time-specific indicators, to allow for heterogeneity along these dimensions.

We also examine whether mutual fund dispositions around the threshold are driven by heterogeneity in investment objectives or fire sale risk. We expect mutual funds to be more sensitive to de minimis risk if a larger share of their portfolio is invested in municipal debt, have an investment objective to hold tax-exempt debt, or have a high investment flow volatility.

[15] https://www.bondbuyer.com/opinion/potential-disclosure-issues-with-discount-munis

4.3 Monetary Policy and Secondary Market Liquidity

We also examine whether contractionary monetary policy amplifies bond illiquidity around the de minimis threshold. Bond prices are inversely related to interest rates, which means that contractionary monetary policy is likely to increase the fraction of bonds facing de minimis risk. To better understand the effect of monetary policy on municipal bond liquidity, we use changes in the federal funds effective rate and measures of monetary policy surprises following Bauer and Swanson (2022) and estimate the following specification:

$$y_{bt} = \sum_{i<-1}^{+4} \beta_i MP\ Measure_t \times Distance_{ibt} + \gamma X_{ibt} + \varepsilon_{bt} \tag{5}$$

The outcome variable of interest, y_{bt} is the total dollar volume sold by customers to dealers in bond b during week t. We examine sales volume for small, medium, and large trades separately to better understand dynamics among both institutional and retail investors. $MP\ Measure_t$ is the one-, four-, eight-, or twelve-week change in policy rates or a measure of monetary policy surprises, while $Distance_{ibt}$ is an indicator variable that takes the value of one if the price of bond b is in interval i away from the de minimis threshold. i includes < -1, -1, $+1$ …, $+4$ corresponding to the $[-10,-1)$, $[-1,0)$, $[0,+1)$ …, $[+3,+4]$ intervals measuring distance from the de minimis threshold in percentage points, respectively. The omitted group in the regressions includes bonds in the $(+4,+10]$ interval. The matrix X_{ibt} comprises of bond, week, and *Distance* fixed effects.

5 Results

5.1 Bond Trading Activity and De Minimis Thresholds

We first examine secondary market trading activity around the de minimis threshold. Figure 1 presents the distribution of bond-weeks within four percentage points of the de minimis threshold, showing that trading activity falls precipitously immediately after bonds cross the threshold. The incidence of trading activity immediately below the threshold is at least three-four times smaller than that immediately above and continues to decline as bonds move further below the de minimis threshold. Thus, at a first approximation secondary market liquidity declines substantially once municipal bonds cross the threshold as the municipal bond market is dominated by highly tax sensitive investors likely to minimize ordinary income taxation.

In Figure 2 we also consider the evolution of three additional measures of bond trading activity around the de minimis threshold conditional on the presence of trading activity—the average number of trades, total par value traded, and trade size across the bond-weeks in our sample. We use customer-to-dealer sales transactions to construct these measures of trading activity because sellers of bonds with purchase prices above the threshold are unaffected by tax considerations. In other words, their actions are likely to be driven by expected future liquidity. Panel (a) shows that the average number of trades above the cutoff is roughly steady with a slight decline from about 1.25 trades to a little less than 1.2 trades as bonds approach the threshold. The average trade size and par value traded, depicted in Panels (b) and (c), increase steeply as bonds approach the cutoff. For example, average trade size increases from about $150,000 2-4 percentage points above the threshold to nearly $300,000 immediately above the threshold. The increase in average trade size combined with the steady evolution of the number of trades suggests that institutional investors ramp up selling above the threshold, while individual investor do not seem to change trading activity. This result is consistent with institutions disposing of bonds in anticipation of low secondary market liquidity below the threshold.

Panel (a) also shows that conditional on trading, the number of trades increases significantly after bonds fall below the de minimis threshold. Trade count increases to 1.3 immediately below the cutoff and up to roughly 1.5 further below the cutoff. These trends are accompanied by strikingly lower average trading volume and average trade size immediately below the cutoff. Further below the threshold, average trading volume and trade size, conditional on trading, recover to values close to the values last seen 2-4 percentage points above the threshold. Taken together with the evidence from Figure 1, these results imply that retail investors represent significantly larger share of realized trades at the same time liquidity in this segment of the market drops precipitously.

Next in Figure 3 we partition the sample into low- (the three panels on the left) and high-duration bonds (the three panels on the right). Low-duration (high-duration) bonds are those with duration of less than or equal to (greater than) three, which is the sample median duration. High-duration bonds have significantly higher sensitivity to interest rate changes than low-duration bonds. Consequently, we expect investors to preemptively dispose of high-duration bonds facing de minimis risk significantly earlier above the threshold than low-duration bonds.

The top left panel of Figure 3 shows a histogram of trading activity of bond-weeks corresponding to low-duration bonds. We find an even larger and more precipitous drop in trading activity at the threshold among low-duration bonds than in the full sample. Similarly, these bonds also exhibit a significant run-up in average trade size and par value traded (the middle and bottom left panels) as they approach the threshold from the right that peaks right before the threshold. The run-up in trading activity is consistent with the low sensitivity of low-duration bonds to interest rate changes, implying that investors have significant flexibility to divest away from these bonds close to the threshold. The steep increase in trade size illustrates most of the activity in the immediate vicinity of the threshold comes from institutional rather than retail investors. Finally, the minimal distribution mass below the cutoff further highlights the significant ability of investors to divest as planned and the strong preference to stay above the de minimis threshold.

The three right panels in Figure 3 show that the trading patterns of high-duration bonds differ markedly from those of low-duration bonds. Specifically, trading incidence is substantially higher 2-4 percentage points above the threshold than immediately above the threshold. At the same time, average trade size is also larger further above the cutoff with total dollar volume remaining fairly constant, suggesting that institutions are more likely to sell high-duration bonds well above the de minimis threshold. These patterns in weekly trading activity are consistent with investors in high-duration bonds responding to de minimis risk earlier than investors in low-duration bonds. Notably, the decline in trading activity is also steeper above than below the threshold.[16]

In Figure 4 we also examine trading dynamics around the de minimis threshold for transactions

[16]Splitting the sample based on remaining maturity generates nearly identical results (see Appendix Figure C.3).

of different sizes. The right panels of Figure 4 show that while all types of investors trade less below than above the threshold, institutional investors trade markedly less than retail investors once bonds fall below the threshold. In other words, retail investors become significantly more important for price formation of bonds below the threshold. The figure also corroborates our earlier conjecture that institutional investors are responsible for the run-up in trading activity immediately above the threshold. Specifically, both the incidence of trading and the average trade size conditional on trading increase substantially immediately above the cutoff for large but not for small and medium trades. In Section 7 we further examine whether the significant institutional investor trading generates selling pressure in this segment of the market.[17]

5.2 Mutual Fund Trading Near the Threshold

In this section, we investigate the mechanism behind the increase in institutional trading activity above the threshold. We focus on bond mutual funds as they hold the largest share of municipal bonds among institutions. Given the institutional holdings data are quarterly, we first compute the average distance of each bond to the de minimis threshold at the quarterly level, which we then use to track the evolution of institutional trading activity.

We first compare activity of mutual funds to that of life insurance companies, which represent a significant share of investing in fixed income securities and tend to follow buy-and-hold investment strategies. Figure 5 shows the typical (median) dollar value of net purchases of municipal securities across mutual funds and life insurance companies. The left portion of Panel (a) indicates that mutual funds are net sellers of municipal bonds above the threshold and that net selling increases substantially as bonds get closer to the threshold. This result matches closely the empirical patterns from Figure 2, where average trade size increases substantially immediately above the cutoff. Once bonds fall below the threshold, net purchases of mutual funds stay close to zero. These trading patterns stand in stark contrast with the activity of life insurance companies (the right portion of Panel (a))—net purchases of municipal bonds by life insurers around the threshold

[17] Appendix Table C.1 further describes trading activity around the de minimis threshold for each trade type.

are negligible. These results corroborate the idea that mutual funds anticipate less liquid markets below the threshold, where investment objectives to minimize income taxes reduces the number of potential buyers.

Table 2 provides estimates of Equation 4 comparing the net municipal bond purchases of mutual funds and life insurers by exploiting the bond-level granularity of the mutual funds holdings data. Column 1 shows that mutual funds are more likely to be net sellers of municipal bonds than life insurers in any interval within 4 percentage points of the threshold. The coefficient increases as bonds approach the threshold from above with the highest relative probability of 21% in the price interval of 0-1 percentage points above the threshold. Columns 2 and 3 show that allowing for time-varying heterogeneity across mutual funds and life insurance companies or for heterogeneity in selecting certain bonds across mutual funds increases the relative probabilities even further.

Panel (b) of Figure 5 shows that the timing of net selling by mutual funds depends on bond duration. The right portion of Panel (b) indicates that mutual funds substantially increase net selling of low-duration bonds as these bonds approach the threshold. In contrast, mutual funds dispose of bonds with longer duration well above the threshold. For example, within the subset of high-duration bonds net selling of mutual funds is the highest 3-4 percentage points above the de minimis threshold and decreases closer to the cutoff. Net selling drops to nearly zero immediately above the cutoff, lending further support to the idea that mutual funds dispose of interest-rate sensitive bonds well above the cutoff in a planned manner. Finally, mutual funds are significant net purchasers of municipal bonds with longer duration that are at least four percentage points above the de minimis threshold. This suggests that as mutual funds exit their positions in bonds close to the threshold they relocate capital to bonds with little de minimis risk.

Figure 6 sheds further light on how the the timing of mutual fund trading activity depends on bond duration by splitting funds into "short-term" (Panel (a)), "intermediate term" (Panel (b)), and "long-term" (Panel (c)) according to their stated investment objective.[18] The average portfolio duration of mutual funds and, consequently, the incentive to sell significantly above the threshold

[18]The sample for this analysis accounts for about 25 percent of the full sample in Figure 5 because a fund's name does not always reveal its duration objective.

is likely to increase as the objective tilts towards long-term bonds. In line with previous results, shorter duration funds are more likely to be net sellers of bonds closer to the threshold. The graph also shows that the net sales of short and intermediate term funds near the cutoff tend to be offset by net purchases at least four percentage points above the cutoff, suggesting that funds reinvest the sale proceeds into bonds with little de minimis risk. Finally, there is little evidence of net selling among long-term funds.

We also examine whether the mutual fund sector fully exits their positions in bonds carrying de minimis risk. The exit of mutual funds is likely to exacerbate municipal bond illiquidity as mutual funds hold the largest share of municipal bonds among institutional investors.[19] Mutual funds also tend to be more active on the secondary market than most other institutions such as banks, insurance companies, or foreign investors. We find that conditional on mutual funds becoming net sellers of a given bond between quarters t and $t-1$, they dispose of the entire position over 75 percent of the time. While our data do not allow us to provide detail on the types of institutions purchasing bonds facing de minimis risk, the widespread disposition of such bonds positions by mutual funds is likely to have adverse effects on future bond liquidity.

Table 3 examines how heterogeneity across mutual funds affects selling propensities by limiting the sample to mutual funds and interacting fund characteristics with the indicators for distance from the de minimis threshold. Funds that are heavily invested in municipal bonds have high incentives to preemptively sell bonds above the threshold, anticipating few buyers buyers below the threshold. Column 1 shows the difference between the activity of bond funds that specialize in municipal bond (municipal bond funds) and that of other bond funds that hold at least some municipal bonds. We find that bonds held by municipal funds are more likely to sell bonds close to the threshold than other types of mutual funds.

Similarly, funds with an investment objective of minimizing tax burden have significant share of their portfolios in municipal bonds and thereby have high incentives to avoid the low liquidity

[19] As of the second quarter of 2022 mutual funds held \$819 billion of outstanding municipal bonds, or roughly 20 percent of total outstanding amount, the second most significant investor in these bonds after households. See Table L.212 in the Financial Accounts of the United States, https://www.federalreserve.gov/releases/z1/20220909/z1.pdf.

below the threshold. To identify such funds, we search all fund names for the phrase "tax-exempt." Column 2 shows that tax-exempt funds are significantly more likely to be net sellers bonds close to the de minimis threshold than other funds, especially when bonds are within 1-2 percent above the threshold. Finally, municipal bond mutual funds hold little cash and may need to sell portfolio holdings quickly when faced with outflows. High flow volatility funds may therefore have incentives to hold relatively more liquid portfolios. Consistent with this idea, in column 3 we find that funds with higher flow volatility, or above median standard deviation of their asset growth rate, contribute more to the overall mutual fund selling of bonds close to the threshold.

6 Contractionary monetary policy and bond illiquidity

De minimis risk is unlikely to be stable over time and is likely to vary with market-wide factors that drive interest rate changes. Figure 7 shows that de minimis risk is highly correlated with the monetary policy cycle. Panel (a) illustrates that as interest rates increase, so does the number of bonds traded below de minimis. Furthermore, contractionary monetary policy increases the share of bonds carrying de minimis riks (at risk of falling below the threshold). Panel (b) shows that during environments with contractionary monetary policy such as most of 2022, over 25 percent of trades in a given week are executed at prices between 0 and 4 percentage points from the de minimis threshold.

While this graphical evidence is striking, it does not allow us to differentiate between anticipation and contemporaneous effects of policy rates. During our sample period, these two effects are intertwined as the Federal Reserve signalled the path of interest rates well in advance and municipal bond holders are likely to have traded on interest rate expectations. Therefore, it is important to separate these effects and examine the extent to which unexpected increases in policy rates drive de minimis risk. Understanding these dynamics is likely to have important implications for municipal bond liquidity in times of stress such as the Covid-19 crisis or the Great Recession.

To shed light on trading activity in response to monetary policy changes we first examine the evolution of bond trading activity around changes in the fed funds rate. Columns 1 and 2 of Table 4 show that weekly increases in the fed funds rate are negatively correlated with par value traded among small and medium-sized trades above the de minimis thresholds. In other words, contractionary monetary policy leads to lower sales activity among retail investors. In stark contracts with these results, column 3 shows that weekly fed fund rates strongly positively predict contemporaneous institutional sales volume above the threshold, amplifying the path to illiquidity documented earlier. Notably, this effect is four times larger in magnitude than the change in trading activity among small and mid-sized trades. Columns 4 and 5 show that institutional sales volume increases immediately above the threshold for the most interest rate-sensitive bonds and over a wider range of prices above the threshold for less sensitive bonds. The lack of response among high-duration bonds over most of the price spectrum around de minimis is consistent with investors having disposed of high-duration bonds well in advance of rate increases, generating a limited response to contemporaneous rate hikes.

In Table 5 we study how changes in policy rates over longer than weekly horizons are correlated with sales activity within the subset of large trades. We find that increases in fed funds rates over four, eight, and twelve weeks translate to additional institutional sales further away from the threshold but these effects are muted relative to the contemporaneous effects (presented for the sake of comparison in column 1). For example, these longer horizon changes generate increase in institutional sales volume of between 4% and 6% only in the interval that is 2-3 percentage points above the de minimis threshold, which pales in comparison to the 9% to 12% contemporaneous increase in sales volume between 1-3 percentage points above the threshold. Finally, longer-horizon increases in the fed funds rate also further depress activity below the threshold. Institutional sales decline by about 9% among bond at least one percentage points below the threshold. There is also weaker evidence that institutional sales decline by about 6% for bonds within one percentage point below the threshold, especially for twelve-quarter changes in the fed funds rate.

To shed light on trading activity in response to sudden and unexpected changes in monetary policy, we use data on monetary policy surprises provided by Bauer and Swanson (2022). Table

6 shows the estimates of equation 5 for small, medium, and large trades across the two measures of monetary policy surprises. The $MPS > 0$ variable in columns 1 through 3 is a weekly measure of monetary policy surprises computed as the positive part of the first principal component of the current quarter and three-quarters ahead eurodollar futures contracts. The $MPS_{ORTH} > 0$ variable in columns 4 through 6 is the positive part of the residual from regressing MPS on the six macro and financial indicators from Table 1 in Bauer and Swanson (2022).

The estimates in columns 1, 2, 4, and 5 shows no or limited response of retail trades to positive monetary policy surprises. The estimates for this subset of the data over most distance bins around the de minimis threshold are small and statistically insignificant. Using the orthogonalized measure of monetary policy responses shows a 1% increase in retail sales activity four percentage points above the threshold and a reduction in sales of 1.3% immediately below the threshold (see column 4). In contrast, columns 3 and 6 show that monetary policy surprises generate a 2.8 to 3.5 percentage points increase in sales volume immediately above the threshold for institutional trades, suggesting that contractionary monetary policy shocks amplify the empirical patterns around the de minimis threshold documented earlier. Unexpected contractionary monetary policy shocks also lead to further reduction in sales activity below the threshold among institutional trades. Overall, these results suggest that monetary policy surprises or sudden increases in market volatility are likely to exacerbate the illiquidity dynamics we illustrate earlier.

7 The de minimis threshold, liquidity, and yield spreads

In this section, we use different measures of liquidity and selling pressure to further illustrate the liquidity channel underlying our results. We also directly address the effect of the de minimis threshold on bond yields.

Markups. We first explore how differences in trading costs between institutional and retail investors shape prices around the de minimis threshold. As retail investors become more important in price formation, average prices may simply reflect higher trading costs typical of retail trades, irrespective of liquidity. To understand such trading costs, we calculate markups of customer purchases over dealer trades for different trade sizes as the difference between average customer purchase prices and interdealer prices in a given week. To the extent that price dynamics reflect higher retail markups, we would not expect changes in markups of institutional trades around the de minimis threshold. If the liquidity deterioration below the threshold is priced by all market participants, we expect an increase in markups for all trades, retail and institutional. Figure 8 lends further support to our hypothesis that liquidity is at the heart of the dynamics around the de minimis price. While markups for retail trades are generally higher than institutional markups, markups across all trade types increase significantly once bond prices cross the threshold. In addition, institutional trades exhibit the largest increase in markups. These results also shed some light onto the large variation in markups in the municipal bond market documented by Griffin, Hirschey and Kruger (2022).

Selling pressure. In section 5 we show that liquidity below the de minimis threshold drops precipitously in terms of both trading incidence and volume. We utilize the selling pressure measure proposed by Feldhütter (2012) to shed additional light on the liquidity dynamics around the cutoff. This measure is equal to the difference in customer sale prices between large and small trades in the same bond and during the same week. In the municipal bond market this price difference is typically large and positive because institutional investors receive favorable pricing relative to retail investors. A decrease in the price difference is indicative of selling pressure as the execution prices of institutional investors worsen. Figure 9 shows that the high institutional trading above the cutoff is associated with lower price differentials than below the cutoff. In other words, the probability of selling pressure and fire sales is substantially larger right above the threshold, which is consistent with the selling activity by mutual funds that we document earlier.

Mutual fund sales and yield spreads. Our previous results show that secondary market liquidity deteriorates after mutual funds dispose of bonds around the de minimis threshold. In the next set of tests, we examine whether mutual fund sales also directly affect bond yields. We expect yield spreads to increase after funds unwind their positions and bonds cross the threshold to the extent that mutual funds are important liquidity providers in the secondary market. To test this hypothesis, we regress yield spreads on an indicator variable that takes the value of one whenever the mutual fund industry collectively disposes of over 25% of its holdings of a given bond in the previous quarter and on the interaction of this variable with the distance to the de minimis threshold indicators.

Columns 1 through 3 of Table 7 show that bonds below the threshold have higher spreads in the aftermath of substantial mutual fund sales for small, medium, and trades. Small and medium trades below the threshold have substantially higher spreads than large trades after large mutual fund sales. In other words, although the reduction in liquidity below the threshold is most likely to adversely affect retail investors, it also has large and negative impact on institutional investors. This finding also helps explain the substantial sales of mutual funds in anticipation of bonds falling below the threshold. In addition, spreads are negative for all trade sizes whenever prices are close but above the threshold, while column 5 shows the presence of a positive premium for small trades famong high-duration bonds 2-4 percentage points above the threshold. This corroborates our result that mutual fund selling in long term bonds starts further away from the threshold compared to bonds with a short remaining maturity with the state of secondary market illiquidity commences earlier. Notably, the roughly 6 basis points negative spreads for small trades of low duration bonds above the de minimis threshold is suggestive of higher demand for low-duration bonds leading to more liquid markets.

Turnover and yield spreads. Finally, we investigate how an alternative measure of liquidity, turnover, is related to yield spreads relative to above-par bonds. We follow Cestau, Green and Schürhoff (2013) and calculate quintiles of quarterly bond turnover, defined as the total quarterly trading volume of a bond divided by the bond's amount outstanding as of the previous quarter. We restrict the sample to the highest and lowest turnover quintiles and we include an interaction term between the lowest turnover quintile indicator and the indicators for distance to the threshold. To the extent that yield spreads are unrelated to illiquidity around the threshold, we do not expect the interaction terms to be significant around the threshold. Yet Table 8 shows that yield spreads are consistently and significantly higher for low-turnover bonds below the de minimis threshold. For both small and large trades, more illiquid bonds command a premium at any distance from the threshold with the premium increasing as bonds approach or fall below the de minimis price. Large sized trades command a liquidity premium only at least one percentage point below the de minimis threshold (column 3). The premium increases earlier for high-duration than for low-duration bonds (see columns 4 and 5). In summary, these findings suggest that liquidity is not only the main driver of the trading dynamics around the de minimis threshold, but also has significant price impact.

8 Conclusion

Exploiting a discontinuity in the tax treatment of municipal bonds, we show that mutual funds' exit from the market leads to substantial illiquidity and illiquidity-induced spikes in bond yield spreads. Below the threshold, mutual funds are largely absent from the price formation process, while retail investors play an increasingly important role. Our results highlight the importance of institutional investor constraints and how such constraints shape asset markets though the "institutional investor channel."

We also show that illiquidity risk induced by mutual fund exit increases significantly in rising interest rates environments such as the current monetary policy tightening. Interest rate changes amplify institutional sales, both contemporaneously and over longer horizons. These dynamics are driven by both the expected and the unexpected component of policy rate changes as positive monetary policy surprises further increase institutional sales volume. Overall, monetary policy speeds up the path to illiquidity in the municipal bond market.

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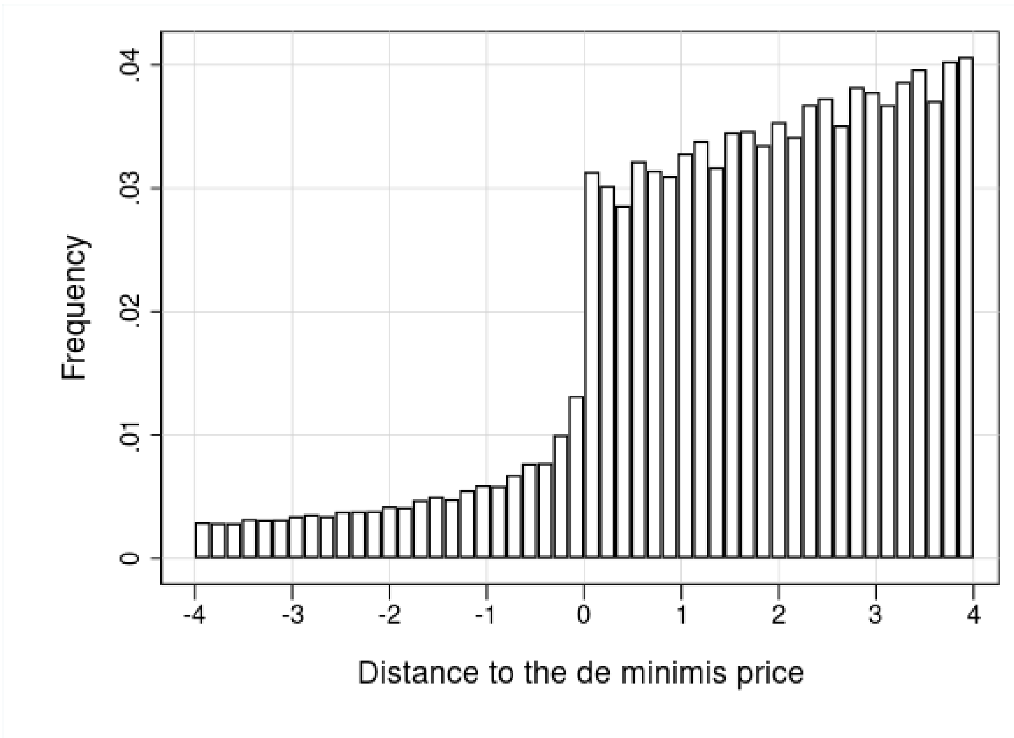
Figures

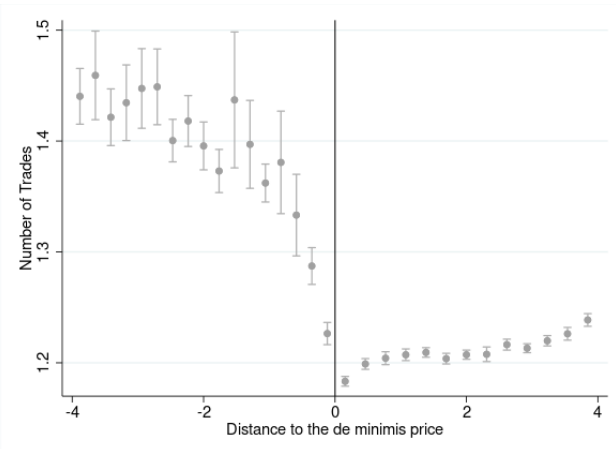
Figure 1: Distribution of Weekly Trades Around the Deminimis Threshold.



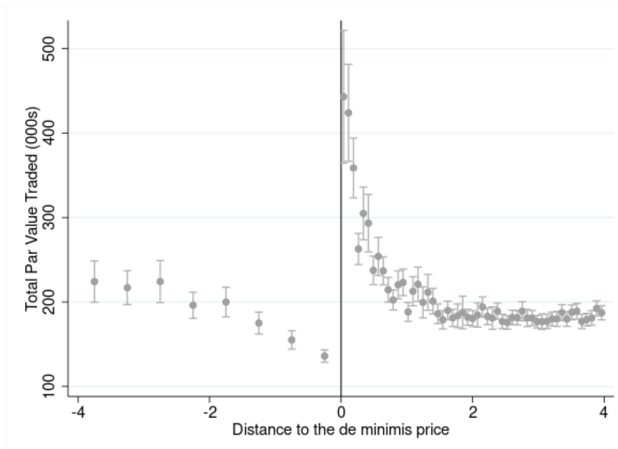
Note: Figure 1 presents a histogram of the incidence of weekly trading activity around the de minimis price threshold.

Figure 2: Secondary Market Liquidity Around the De Minimis Threshold.

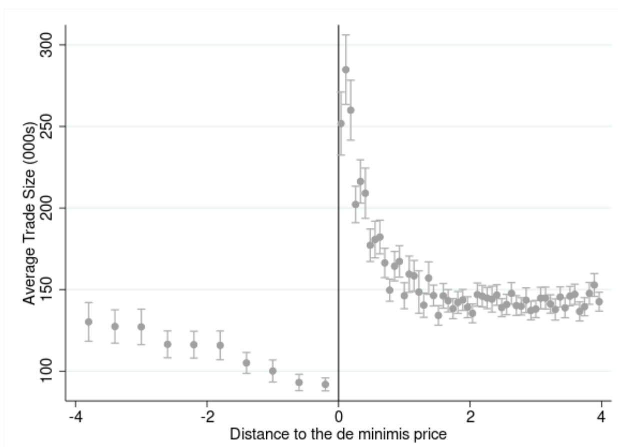
(a) Number of Trades



(b) Par Value Traded



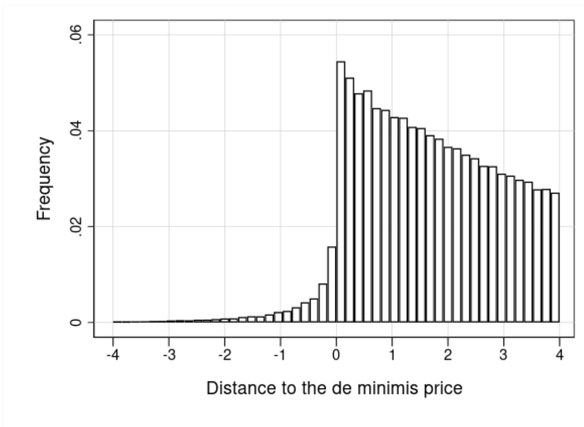
(c) Trade Size



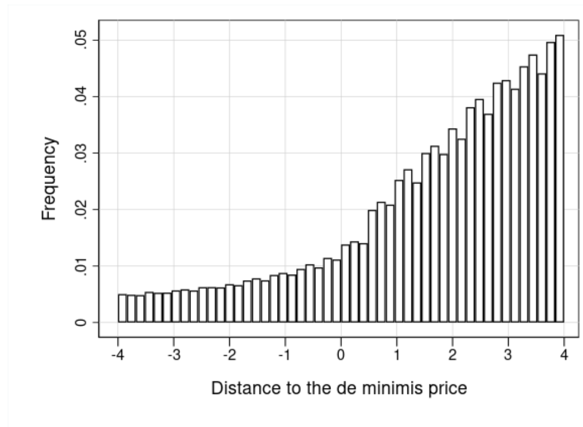
Note: Figure 2 presents the distributions of three measures of secondary municipal bond market activity around the de minimis threshold: the average number of trades, par value traded (in 000s of dollars), and the average trade size (in 000s of dollars) in a given week. We construct these measures using customer-to-dealer sales transactions. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the de minimis price, where positive (negative) values indicate that the trade price is above (below) the de minimis price.

Figure 3: Secondary Market Liquidity, the De Minimis Threshold, and Bond Duration.

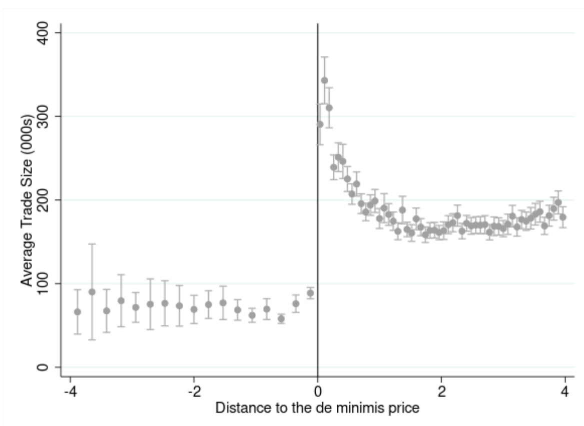
Weekly Trades Distribution, Low Duration



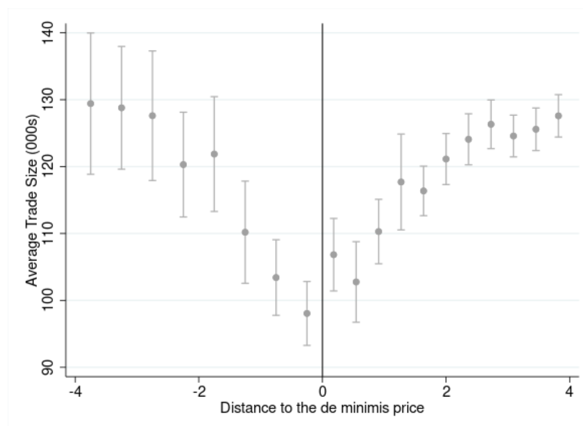
Weekly Trades Distribution, High Duration



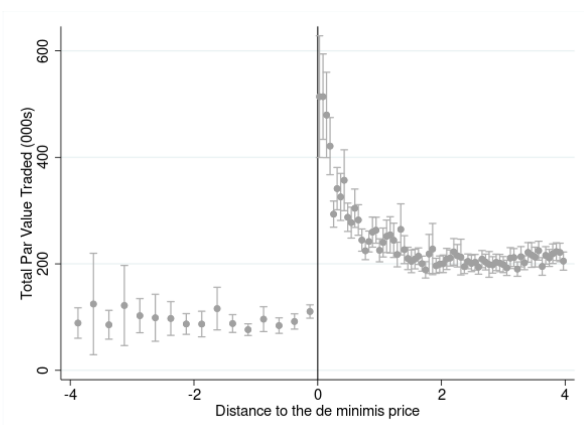
Avg. Trade Size, Low Duration



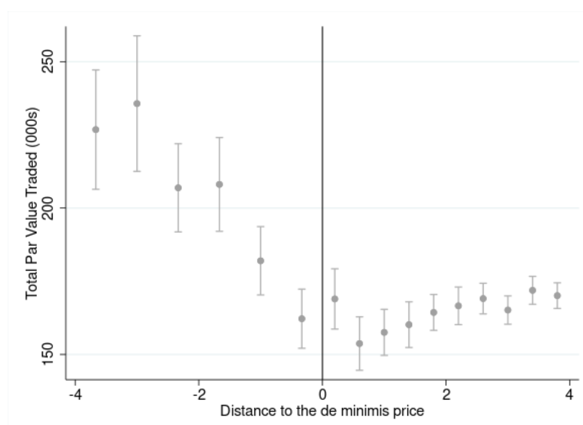
Avg. Trade Size, High Duration



Par Value Traded, Low Duration



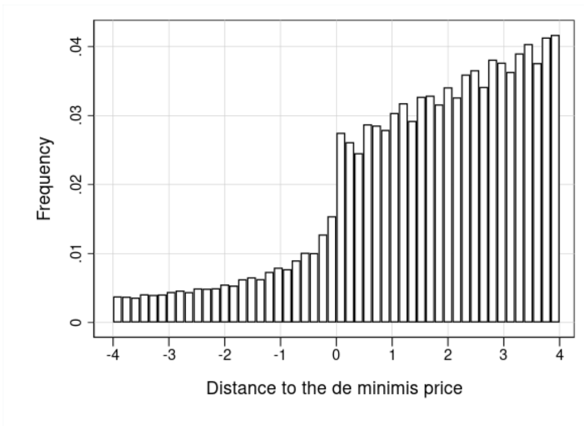
Par Value Traded, High Duration



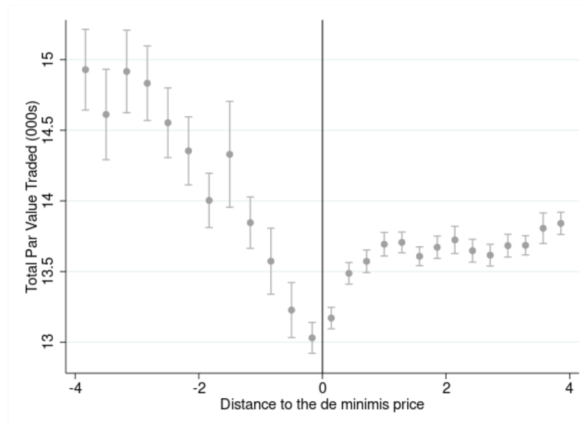
Note: Figure 3 presents the distributions of three measures of secondary municipal bond market activity around the de minimis threshold for both low and high duration bonds: the incidence of trading, and the averages of total par value traded (in 000s of dollars) and trade size (in 000s of dollars) in a given week. We use customer-to-dealer sales transactions to construct average total par value traded and trade size. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the de minimis price, where positive (negative) values indicate that the trade price is above (below) the de minimis price. Low duration bonds are those with duration roughly ≤ 3 (the sample median duration) and long-term bonds are those with duration > 3.

Figure 4: Trading Volume Around the De Minimis Threshold and Trade Size.

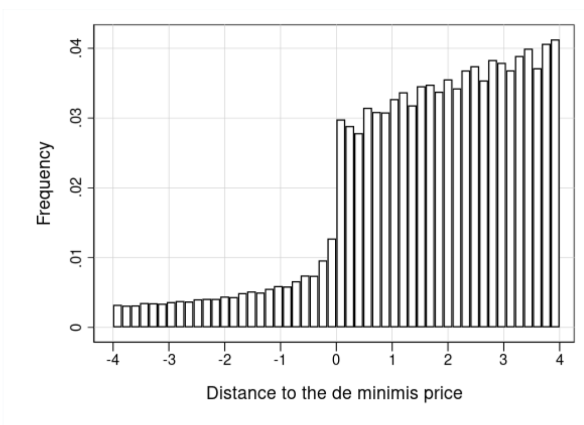
Small Trades, Incidence of Trading



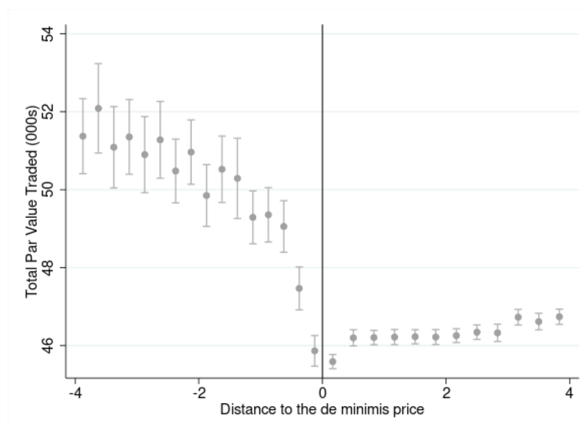
Small Trades, Par Value Traded



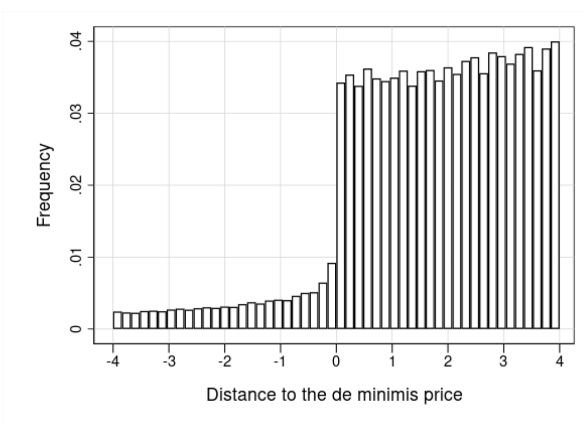
Medium Trades, Incidence of Trading



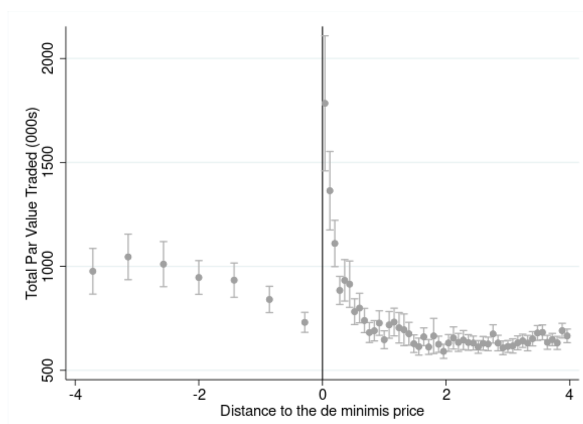
Medium Trades, Par Value Traded



Large Trades, Incidence of Trading



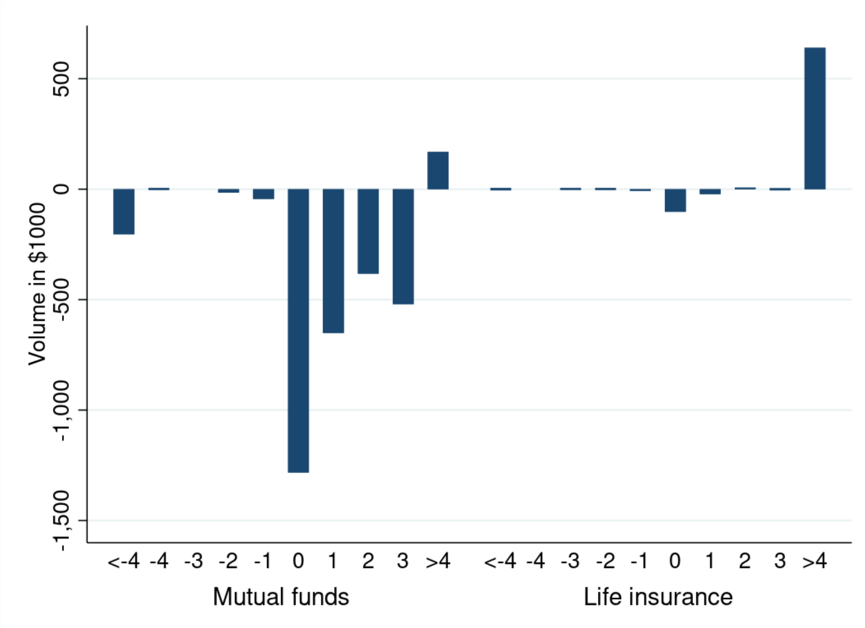
Large Trades, Par Value Traded



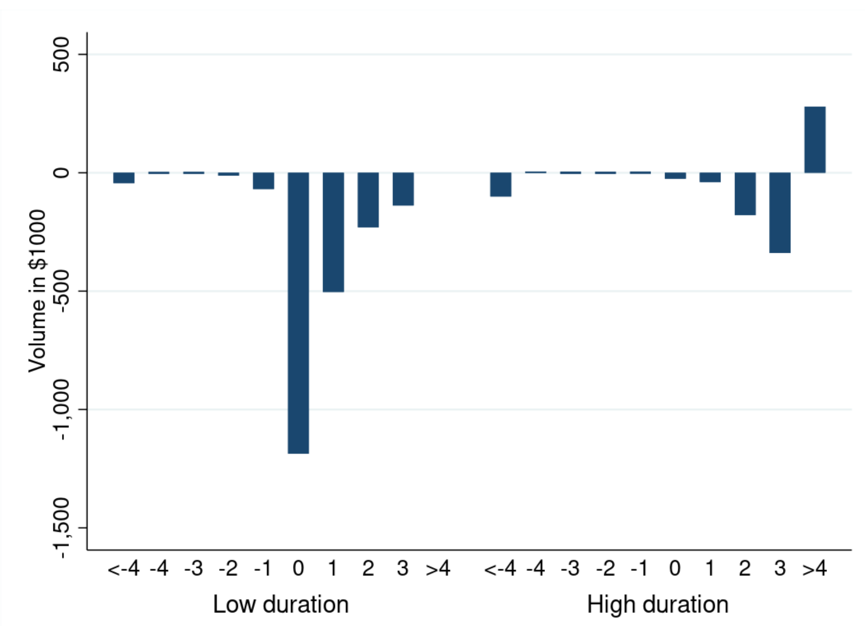
Note: Figure 4 presents the distributions of the incidence of trading activity and total par value traded around the de minimis threshold for small, medium, and large trades. We use customer-to-dealer sales transactions to construct total par value traded. We define trades as "large" whenever the underlying par value of the transaction exceeds $100,000, "small" trades whenever the par value is below $25,000, and "medium" trades whenever the par value is between $25,000 and $100,000. The three panels on the left show histograms of the incidence of trading within the [-4,4] interval, while the panels on the right present averages and 95% confidence intervals for total par value within the [-4,4] interval around the de minimis price. A positive (negative) distance from the de minimis threshold indicates that the trade price is above (below) the de minimis.

Figure 5: **Net changes of traded muni bonds around the tax threshold**

(a) Net buying of municipal bonds: Mutual funds vs life insurers



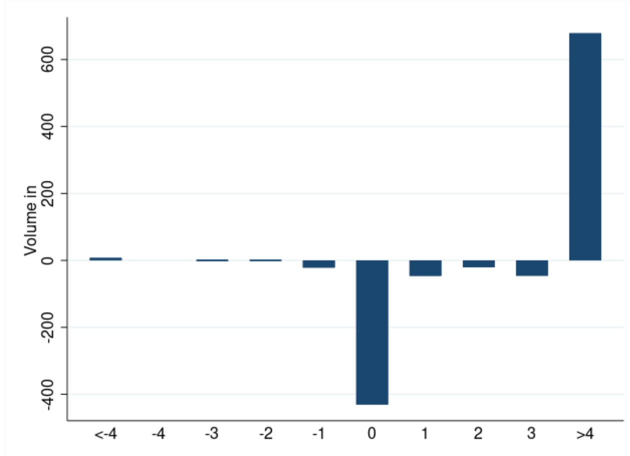
(b) Net buying of municipal bonds by mutual funds: Low vs high duration



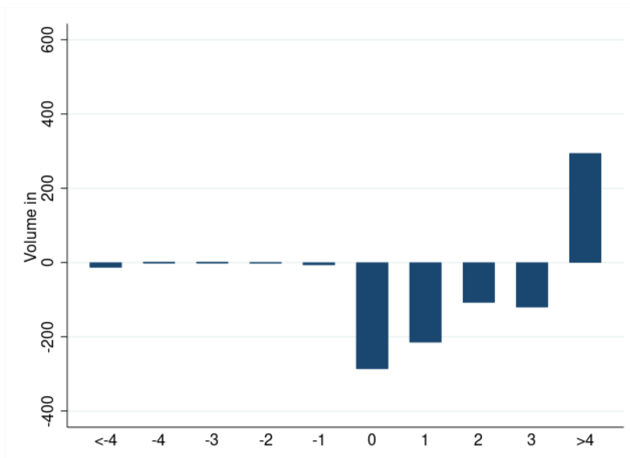
Note: Panel (a) of Figure 5 shows the median quarterly net change in the total par dollar amount of municipal bonds held by mutual funds (left portion) and life insurance companies (right portion) around the de minimis price. Panel B shows the median quarterly net change in the par value of low-duration bonds (left portion) and high-duration bonds (right portion) held by mutual funds. In both panels, municipal bonds are grouped according to their average distance to the threshold in a given quarter. < -4, -4, -3, ..., $+4$, $> +4$ correspond to the < -4, $[-4,-3)$, $[-3,-2)$, ..., $[+3,+4]$, $[> +4]$ intervals measuring distance from the de minimis threshold in percentage points of par value. We limit the sample to bonds that trade at least once in a given quarter.

Figure 6: Net changes of traded muni bonds around the tax threshold by different fund types.

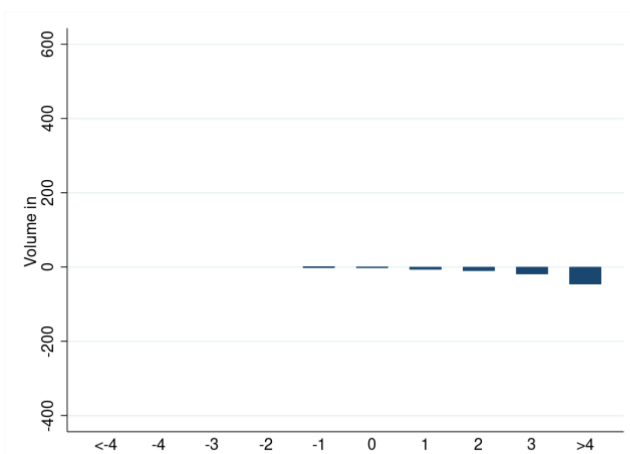
(a) Short-term funds



(b) Intermediate-term funds



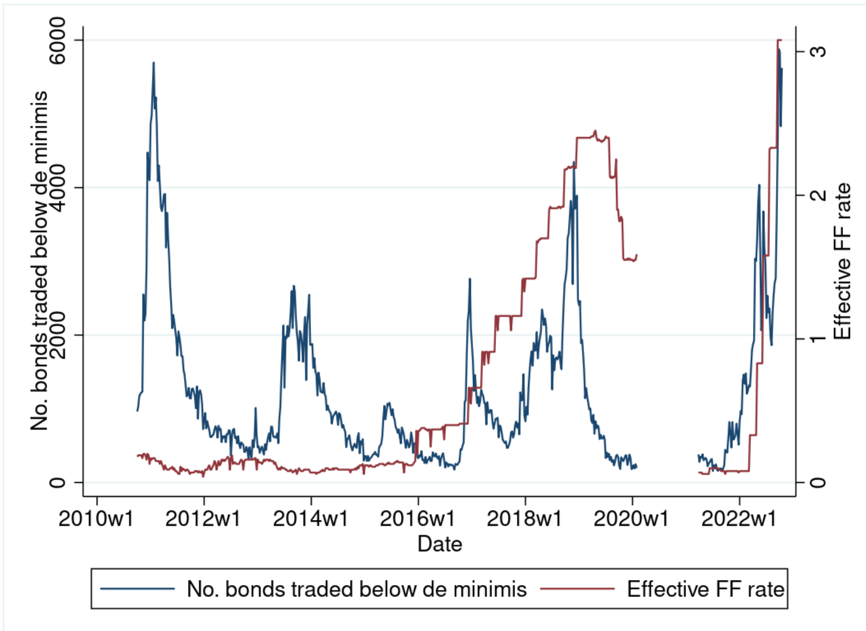
(c) Long-term funds



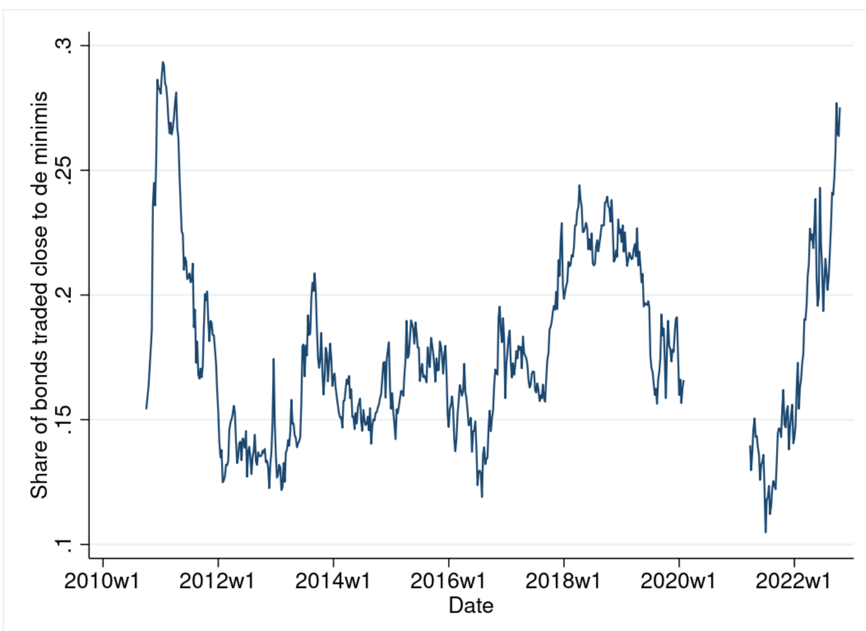
Note: Figure 6 shows the median quarterly net change in total par dollar amount of municipal bonds held by short-term (Panel (a)), intermediate-term (Panel (b)), and long-term mutual funds (Panel (c)) around the de minimis price. We classify mutual funds as short-, intermediate-, or long-term fund whenever a fund's name specifically mentions of such a strategy. $< -4, -4, -3, \ldots, +4, > +4$ correspond to the < -4, $[-4, -3)$, $[-3, -2)$, $\ldots$, $[+3, +4]$, $[> +4]$ intervals measuring distance from the de minimis threshold in percentage points of par value. We limit the sample to bonds that trade at least once in a given quarter.

Figure 7: **De minimis risk over the monetary policy cycle**

(a) Fed funds rate and bonds below the de minimis price

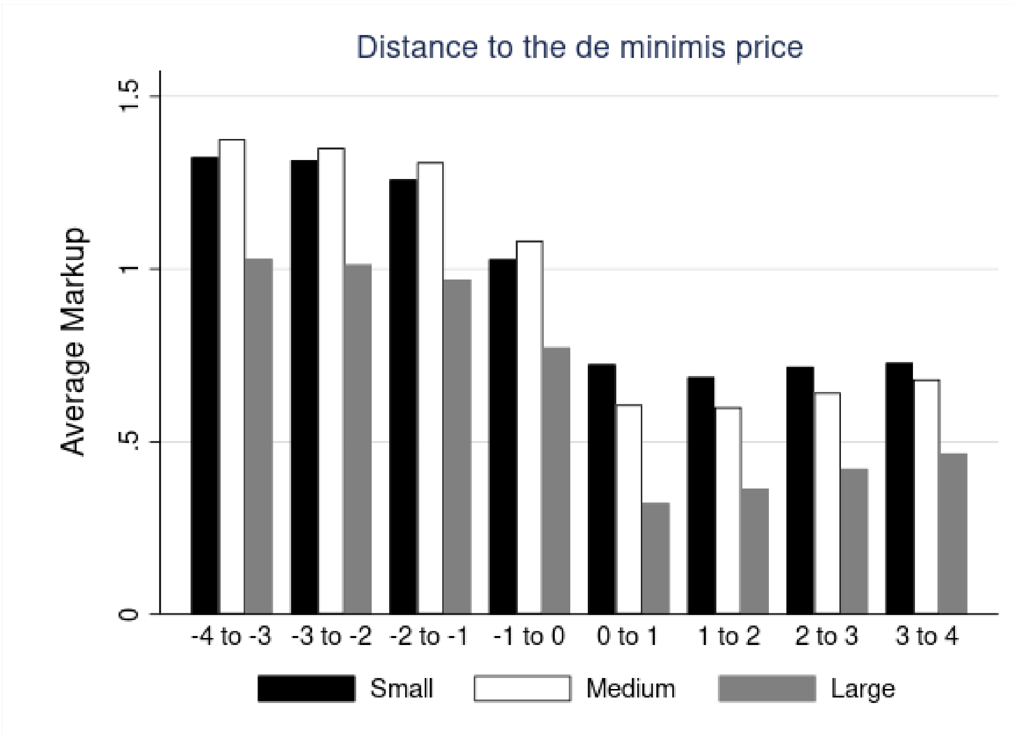


(b) Bonds at risk



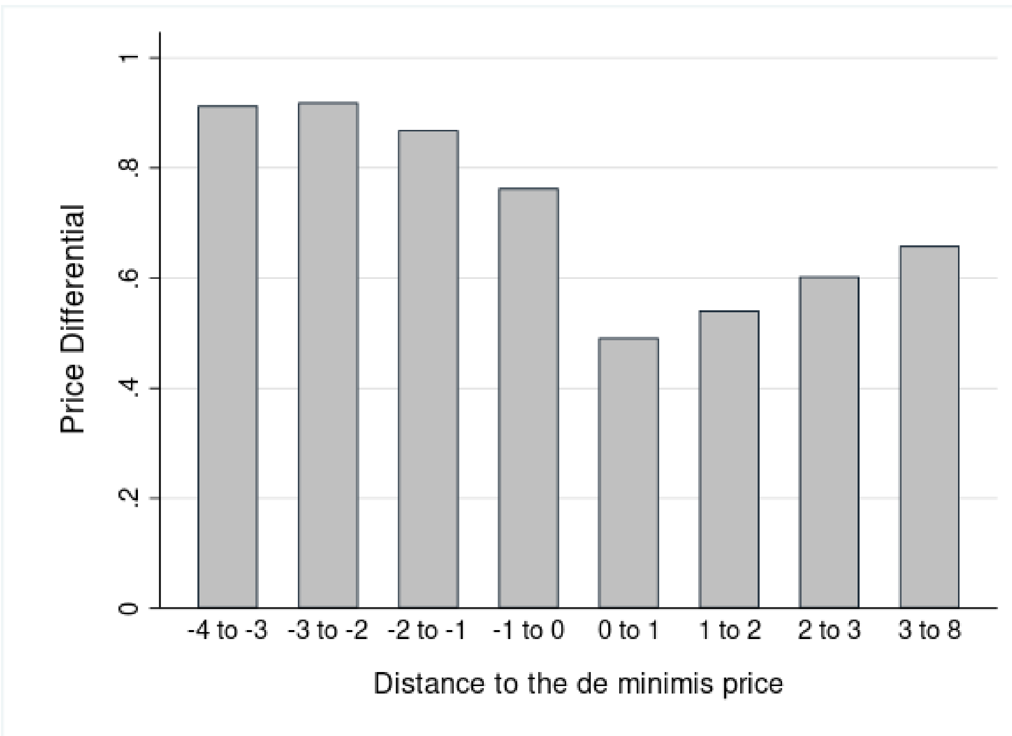
Note: Panel (a) of Figure 7 plots the number of municipal bonds that trade from zero to four percentage points below the de minimis price in a given week (the blue line) against the federal funds effective rate (the red line). Panel (b) plots the share of bonds in the secondary market that trade from zero to four percentage points above the de minimis threshold in a given week.

Figure 8: Markups around the de minimis threshold.



Note: Figure 8 presents the average markups for small, medium, and large trades around the de minimis threshold. We define trades as "large" whenever the total par dollar amount of the transaction exceeds \$100,000, "small" trades whenever the total par amount is below \$25,000, and "medium" trades whenever the total par amount is between \$25,000 and \$100,000. The average markup is the difference between weekly average customer buy prices and weekly average inter-dealer prices.

Figure 9: Selling pressure around the de minimis threshold.



Note: Figure 9 presents the average price differential between large and small sale transactions around the de minimis threshold. We define trades as "large" whenever the total par dollar amount of the transaction exceeds \$100,000, "small" trades whenever the total par amount is below \$25,000, and "medium" trades whenever the total par amount is between \$25,000 and \$100,000. We compute the price differential from average weekly customer-to-dealer sale prices across large and small trades.

Tables

Table 1: Trading Characteristics

Table 1 presents summary statistics for secondary market trading characteristics of bonds in our panel. The table also compares municipal bond trading activity across small, medium, and large trades. We define trades as "large" whenever the total par dollar amount of the transaction exceeds $100,000, "small" trades whenever the total par amount is below $25,000, and "medium" trades whenever the total par amount is between $25,000 and $100,000.

	Mean	SD	Obs	25^{th}	50^{th}	75^{th}
Dollar Volume (000s)	241.63	1687.06	13,520,286	20.00	40.00	100.00
Small	14.45	12.94	5,318,693	10.00	10.00	20.00
Medium	48.27	38.09	6,165,772	25.00	40.00	50.00
Large	835.57	3255.26	3,461,693	100.00	200.00	500.00
Number of Trades	1.29	1.39	13,520,286	1.00	1.00	1.00
Small	1.18	1.30	5,318,693	1.00	1.00	1.00
Medium	1.16	0.79	6,165,772	1.00	1.00	1.00
Large	1.13	0.61	3,461,693	1.00	1.00	1.00
Yield (Percent)	2.56	1.40	13,281,325	1.48	2.32	3.41
Small	2.90	1.43	5,216,315	1.80	2.66	3.78
Medium	2.55	1.40	6,067,123	1.45	2.28	3.40
Large	2.26	1.39	3,375,997	1.17	2.01	3.11
Yield Spread, Small	2.83	1.43	2,696,934	1.66	2.75	3.83
Yield Spread, Medium	2.44	1.45	2,647,489	1.22	2.15	3.50
Yield Spread, Large	2.07	1.50	1,071,215	0.82	1.65	3.19
FF Rate	0.66	0.84	7,579,182	0.09	0.16	1.16
ΔFF	0.01	0.09	7,579,182	0.00	0.00	0.00
Δ_4FF	0.05	0.16	7,579,182	-0.01	0.00	0.01
Δ_8FF	0.08	0.23	7,579,182	-0.01	0.00	0.04
Δ_{12}FF	0.12	0.33	7,579,182	-0.01	0.01	0.21
MPS>0	0.06	0.24	7,579,182	0.00	0.00	0.00
$MPS_{orth}>0$	0.07	0.26	7,579,182	0.00	0.00	0.00
MPS<0	0.08	0.26	7,579,182	0.00	0.00	0.00
$MPS_{orth}<0$	0.06	0.25	7,579,182	0.00	0.00	0.00
Low Turnover	0.13	0.34	3,902,280	0.00	0.00	0.00
MF Sales	0.03	0.17	3,771,145	0.00	0.00	0.00
Distance to de minimis	9.80	7.73	21153278	4.37	9.08	14.97

Table 2: Selling around deminimis threshold by mutual funds and life insurers

Table 2 presents estimates of Equation 4. The outcome variable in all specifications takes the value of one if an asset manager is a net seller of a given bond b during quarter t. $Mutual fund$ is an indicator variable that takes the value of one for mutual funds and zero for life insurers. The matrix X comprises of bond, manager, and time fixed effects, as specified in each column. The standard errors are clustered at the institution level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
Mutual fund $\times$			
Distance < -4	0.029***	0.063***	0.063***
	(0.005)	(0.004)	(0.004)
Distance $= -4$	0.052***	0.074***	0.074***
	(0.006)	(0.006)	(0.006)
Distance $= -3$	0.071***	0.098***	0.098***
	(0.007)	(0.006)	(0.006)
Distance $= -2$	0.051***	0.075***	0.075***
	(0.006)	(0.005)	(0.005)
Distance $= -1$	0.098***	0.117***	0.117***
	(0.008)	(0.008)	(0.008)
Distance $= +1$	0.208***	0.230***	0.230***
	(0.018)	(0.015)	(0.015)
Distance $= +2$	0.103***	0.116***	0.116***
	(0.008)	(0.005)	(0.005)
Distance $= +3$	0.056***	0.066***	0.066***
	(0.004)	(0.005)	(0.005)
Distance $= +4$	0.040***	0.046***	0.046***
	(0.005)	(0.004)	(0.004)
Observations	4,915,102	4,804,721	4,804,721
R-squared	0.159	0.346	0.346
Fund FE	Y	N	N
Cusip FE	Y	Y	N
Time FE	Y	N	N
Fund-Time FE	N	Y	Y
Fund-Cusip FE	N	N	Y

Table 3: Selling around de minimis threshold: Differences between mutual funds

Table 3 reports estimates of Equation 4. The outcome variable in all specifications takes the value of one if a mutual fund is a net seller of a given bond b during quarter t. The indicator variables x_f differs across columns. In column 1, $x_f = MuniFund_f$, an indicator that takes the value of one if fund f invests more than 90 percent of its assets in municipal bonds, and zero otherwise. In column 2, $x_f = TaxExempt_f$ is an indicator variable that takes the value of one if fund f explicitly mentions tax exemption in its name. In column 3, $x_f = FlowVolatility_f$ is an indicator variable that take the value of one if fund f's standard deviation of asset growth over the sample period is above the median standard deviation across all funds. The matrix X comprises of bond, fund, and time fixed effects, as specified in each column. The standard errors are clustered at the institution level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
$x_f \times$			
Distance < -4	0.063***	0.058***	0.064***
	(0.005)	(0.009)	(0.008)
Distance $= -4$	0.074***	0.082***	0.072***
	(0.006)	(0.012)	(0.010)
Distance $= -3$	0.101***	0.121***	0.093***
	(0.007)	(0.012)	(0.011)
Distance $= -2$	0.074***	0.075***	0.071***
	(0.006)	(0.010)	(0.009)
Distance $= -1$	0.112***	0.139***	0.104***
	(0.008)	(0.014)	(0.013)
Distance $= +1$	0.238***	0.296***	0.200***
	(0.016)	(0.014)	(0.028)
Distance $= +2$	0.121***	0.138***	0.093***
	(0.005)	(0.007)	(0.011)
Distance $= +3$	0.069***	0.071***	0.050***
	(0.005)	(0.009)	(0.008)
Distance $= +4$	0.048***	0.049***	0.034***
	(0.004)	(0.007)	(0.008)
Observations	3,824,263	3,824,263	3,824,263
R-squared	0.337	0.333	0.331
Fund-Cusip FE	Y	Y	Y
Fund-Time FE	Y	Y	Y

Table 4: Trading around the de minimis threshold and contemporaneous fed funds rate changes

Table 4 reports regression estimates of Equation 5, where the outcome variable of interest is the natural logarithm of the total dollar volume of customer sales in bond b and week w. The sample is limited to small trades in columns 1, medium trades in columns 2, and large trades in columns 3 through 5. ΔFF is the weekly change in the federal funds effective rate. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{< -1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. The standard errors are double clustered at the bond and week level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
	Log(Par Value Traded)				
Trade Size	Small	Medium	Large	Large	Large
Duration	—	—	—	Low	High
ΔFF $\times$ Distance < -1	-0.008	-0.063***	0.036	-0.021	0.063
	(0.014)	(0.024)	(0.111)	(0.176)	(0.108)
ΔFF $\times$ Distance $= -1$	-0.010	-0.006	0.078	0.081	0.080
	(0.021)	(0.020)	(0.066)	(0.114)	(0.091)
ΔFF $\times$ Distance $= +1$	-0.038**	-0.026**	0.140***	0.162***	0.243***
	(0.015)	(0.011)	(0.047)	(0.057)	(0.094)
ΔFF $\times$ Distance $= +2$	-0.031**	-0.038***	0.055	0.135**	-0.017
	(0.013)	(0.011)	(0.044)	(0.055)	(0.093)
ΔFF $\times$ Distance $= +3$	-0.005	-0.018	0.090**	0.124**	0.087
	(0.014)	(0.012)	(0.041)	(0.055)	(0.069)
ΔFF $\times$ Distance $= +4$	0.000	-0.042***	0.055	0.093*	0.034
	(0.017)	(0.010)	(0.055)	(0.054)	(0.087)
Observations	2,797,098	3,151,453	1,470,045	714,560	717,715
R-squared	0.254	0.227	0.401	0.395	0.412
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table 5: The de minimis threshold and fed funds rate changes over longer horizons

Table 5 reports regression estimates of Equation 5, where the outcome variable of interest is the natural logarithm of the total dollar volume of customer sales in bond b and week w. The sample is limited to large trades. ΔFF variable is the one-week, four-week, eight-week, and twelve-week change in the federal funds effective rate in columns 1, 2, 3, and 4, respectively. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{< -1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. The standard errors are double clustered at the bond and week level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
	Log(Par Value Traded)			
ΔFF Horizon	1 Qtr	4 Qtrs	8 Qtrs	12 Qtrs
ΔFF × Distance < -1	0.036	-0.090*	-0.094	-0.087***
	(0.111)	(0.054)	(0.058)	(0.031)
ΔFF × Distance $= -1$	0.078	-0.020	-0.063	-0.059*
	(0.066)	(0.063)	(0.050)	(0.034)
ΔFF × Distance $= +1$	0.140***	-0.002	-0.018	-0.023
	(0.047)	(0.038)	(0.026)	(0.019)
ΔFF × Distance $= +2$	0.055	0.005	0.038*	0.016
	(0.044)	(0.028)	(0.021)	(0.016)
ΔFF × Distance $= +3$	0.090**	0.060**	0.052***	0.035**
	(0.041)	(0.030)	(0.020)	(0.016)
ΔFF × Distance $= +4$	0.055	0.005	0.018	0.011
	(0.055)	(0.027)	(0.018)	(0.015)
Observations	1,470,045	1,470,045	1,470,045	1,470,045
R-squared	0.401	0.401	0.401	0.401
Bond FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y

Table 6: Trading around the de minimis threshold and monetary policy surprises

Table 6 reports regression estimates of Equation 5, where the outcome variable of interest is the natural logarithm of the total dollar volume of customer sales in bond b and week w. The sample is limited to small trades in columns 1 and 4, medium trades in columns 2 and 5, and large trades in columns 3 and 6. The MP variable in columns 1 through 3 is a weekly measure of monetary policy surprises computed as the positive part of the first principal component of the current quarter and three-quarters ahead eurodollar futures contracts ($MPS > 0$). The MP variable in columns 4 through 6 is the positive part of the residual from regressing MPS on the six macro and financial indicators from Table 1 in Bauer and Swanson (2022) ($MPS_{ORTH} > 0$). $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{< -1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. The standard errors are double clustered at the bond and week level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)	(6)
			Log(Par Value Traded)			
		MPS>0			MPS$_{ORTH}>0$	
Trade Size	Small	Medium	Large	Small	Medium	Large
MP $\times$ Distance < -1	0.011	0.011	-0.009	0.004	0.010	-0.036*
	(0.012)	(0.010)	(0.030)	(0.008)	(0.010)	(0.019)
MP $\times$ Distance $= -1$	-0.007	-0.013	0.008	-0.013*	-0.007	-0.002
	(0.008)	(0.008)	(0.032)	(0.007)	(0.008)	(0.028)
MP $\times$ Distance $= +1$	0.002	-0.008	0.035**	0.006	-0.000	0.028*
	(0.005)	(0.005)	(0.016)	(0.006)	(0.005)	(0.016)
MP $\times$ Distance $= +2$	0.006	-0.006	-0.005	0.007	-0.000	-0.015
	(0.005)	(0.005)	(0.016)	(0.005)	(0.005)	(0.014)
MP $\times$ Distance $= +3$	0.005	-0.004	-0.005	0.007	-0.000	0.000
	(0.005)	(0.004)	(0.013)	(0.006)	(0.004)	(0.012)
MP $\times$ Distance $= +4$	0.001	0.000	0.023	0.010**	0.003	0.021
	(0.005)	(0.004)	(0.015)	(0.005)	(0.004)	(0.014)
Observations	2,797,098	3,151,453	1,470,045	2,797,098	3,151,453	1,470,045
R-squared	0.254	0.227	0.401	0.254	0.227	0.401
Bond FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y

Table 7: Mutual fund sales and yield spreads around the de minimis threshold.

Table 7 reports regression estimates of $y_{b,w} = \sum_{i<-1}^{+4} \beta_i (Sales_{bq} \times Distance_{ibw}) + \gamma X_{b,w} + \varepsilon_{b,w}$, where $y_{b,w}$ is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and hypothetical yields of bonds above par in the same week and with the same maturity computed using zero rates from the Svensson extension of Nelson-Siegel method (Svensson, 1994; Nelson and Siegel, 1987). Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- or high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above the median. $Sales_{b,q-1}$ is an indicator variable that takes the value of one whenever the mutual fund industry reduces its exposure to bond b in the previous quarter $q-1$ by at least 25%. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{<-1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 30 years. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. Standard errors are double clustered at the week and bond level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Sales × Distance <-1	0.216***	0.134***	0.062	0.355***	0.076***
	(0.047)	(0.045)	(0.048)	(0.111)	(0.024)
Sales × Distance $=-1$	0.776***	0.656***	0.375***	0.832***	0.069**
	(0.094)	(0.094)	(0.083)	(0.105)	(0.028)
Sales × Distance $=+1$	0.221***	0.226***	0.099***	0.026	0.044*
	(0.024)	(0.021)	(0.014)	(0.025)	(0.023)
Sales × Distance $=+2$	-0.012	-0.005	-0.001	-0.060***	0.046
	(0.016)	(0.012)	(0.009)	(0.016)	(0.031)
Sales × Distance $=+3$	-0.042**	-0.023*	-0.021**	-0.063***	0.095***
	(0.017)	(0.012)	(0.010)	(0.016)	(0.036)
Sales × Distance $=+4$	0.006	0.018	-0.000	-0.059***	0.119***
	(0.018)	(0.013)	(0.009)	(0.017)	(0.031)
Observations	2,696,934	2,647,489	1,071,215	1,068,038	1,614,431
R-squared	0.772	0.838	0.898	0.759	0.711
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table 8: Quarterly turnover and yield spreads around the de minimis threshold.

Table 8 reports regression estimates $y_{bw} = \sum_{i<-1}^{+4} \beta_i (Low\ Turnover_{bq} \times Distance_{ibw}) + \gamma X_{bw} + \varepsilon_{bw}$, where y_{bw} is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and hypothetical yields of bonds above par in the same week and with the same maturity computed using zero rates based on the Svensson extension of Nelson-Siegel method (Svensson, 1994; Nelson and Siegel, 1987). Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- and high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above that value. $Low\ Turnover_{b,q-1}$ is an indicator variable that takes the value of one whenever a bond b is in the lowest (the first) quintile of quarterly turnover, or total quarterly trading volume of bond b divided by the dollar value outstanding of bond b as of the previous quarter $q-1$. The sample consists of bonds either in the first or the fifth quintiles of turnover. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{<-1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 30 years. Standard errors are double clustered at the bond and week level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Low Turnover × Distance< -1	0.001	-0.003	0.023	0.005	0.048***
	(0.010)	(0.010)	(0.019)	(0.041)	(0.007)
Low Turnover × Distance$= -1$	0.090***	0.057***	0.094***	0.143***	0.063***
	(0.020)	(0.020)	(0.032)	(0.030)	(0.009)
Low Turnover × Distance$= +1$	0.078***	0.103***	0.027**	0.084***	0.098***
	(0.011)	(0.010)	(0.012)	(0.014)	(0.009)
Low Turnover × Distance$= +2$	0.077***	0.103***	0.038***	-0.005	0.176***
	(0.008)	(0.007)	(0.010)	(0.011)	(0.012)
Low Turnover × Distance$= +3$	0.087***	0.106***	0.035***	-0.082***	0.182***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.012)
Low Turnover × Distance$= +4$	0.067***	0.081***	0.034***	-0.081***	0.124***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.009)
Observations	2,091,728	2,178,105	961,860	842,566	1,217,578
R-squared	0.782	0.851	0.919	0.777	0.743
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Online Appendix: Not For Publication

This appendix includes several sections of supplemental information. Appendix A contains definitions for all the variables used in the paper.

A Variable Definitions

Variable Name	Description
Log(Par Value Traded)	The natural logarithm of total dollar par value traded of customer sale transactions in a given bond-week. *Source:* MSRB
Number of trades	The total number of customer sales transaction in a given bond-week *Source:* MSRB
Trade size	The total customer purchase dollar volume divided by the number of trades in a given bond-week. We define a trade as "large" whenever the par dollar amount of the transaction exceeds \$100,000, as "small" whenever the par dollar amount is below \$25,000, and as "medium" whenever the par dollar amount is between \$25,000 and \$100,000. *Source:* MSRB
Price differential	The difference between average customer sale prices of large and small trades in a given bond-week. *Source:* MSRB
Markup	The difference between the average customer purchase price and the average inter-dealer price for a given bond-week. We calculate markups separately for small, medium, and large trades. *Source:* MSRB
Mutual fund	An indicator variable that takes the value of one whenever an institution is a mutual funds and zero otherwise. *Source:* eMaxx
Distance $= x$	An indicator variable that takes the value of one whenever the average price on the secondary market is in interval i from its de minimis threshold *Source:* MSRB and authors' calculations
MuniFund	An indicator that takes the value of one whenever a mutual fund invests over 90 percent of its assets in municipal bonds, and zero otherwise. *Source:* eMaxx
TaxExempt	An indicator variable that takes the value of one whenever the name name of a mutual fund contains the phrase "tax exempt", and zero otherwise. *Source:* eMaxx
Flow volatility	An indicator variable that takes the value of one whenever the standard deviation of a mutual fund's assets growth rate is above the sample median standard deviation, and zero otherwise. *Source:* eMaxx

Continued on next page

Table A.1 – *Continued from previous page*

Variable	**Description**
ΔFF	The one-, four-, eight-, or twelve-week change in the federal funds effective rate. *Source:* Board of Governors of the Federal Reserve System
MPS	The first principal component of the current quarter and three-quarters ahead eurodollar futures contracts. *Source:* Bauer and Swanson (2022)
$MPS > 0$	A weekly measure of monetary policy surprises computed as the positive part of the first principal component of the current quarter and three-quarters ahead eurodollar futures contracts. *Source:* Bauer and Swanson (2022)
$MPS_{ORTH} > 0$	A weekly measure of monetary policy surprises computed as the positive part of the residual from regressing MPS on the six macro and financial indicators from Table 1 in Bauer and Swanson (2022).
Sales	An indicator variable that takes the value of one whenever the mutual fund industry disposes of at least 25% of their position in a given municipal bond as of the previous quarter, and zero otherwise. *Source:* eMaxx
Turnover	The total dollar par value traded of a bond divided by the bond's outstanding dollar amount as of a given quarter *Source:* MSRB and Mergent
Low turnover	An indicator variable that takes the value of one whenever a bond is in the lowest quintile of turnover as of the previous quarter, and zero otherwise. *Source:* MSRB and Mergent

B Calculation of Yield Spreads

We calculate yield spreads of bonds around the de minimis threshold relative to the hypothetical yields of above-par bonds computed from zero rates based on the Svensson extension of the Nelson-Siegel model (Nelson and Siegel, 1987; Svensson, 1994). Following Ang, Bhansali and Xing (2010), we first use dealer transactions to create weighted average yields in each remaining maturity category for each week and trade type (small, medium, and large trades). The remaining maturity categories run from six months through thirty years in six-month increments. We then use the yields of remaining maturities of up to 24, 23, and 11.5 years for small, medium, and large trades, respectively, to compute zero rates. This ensures the zero rate computations in each maturity-week-trade size cell are based on at least thirty observations.

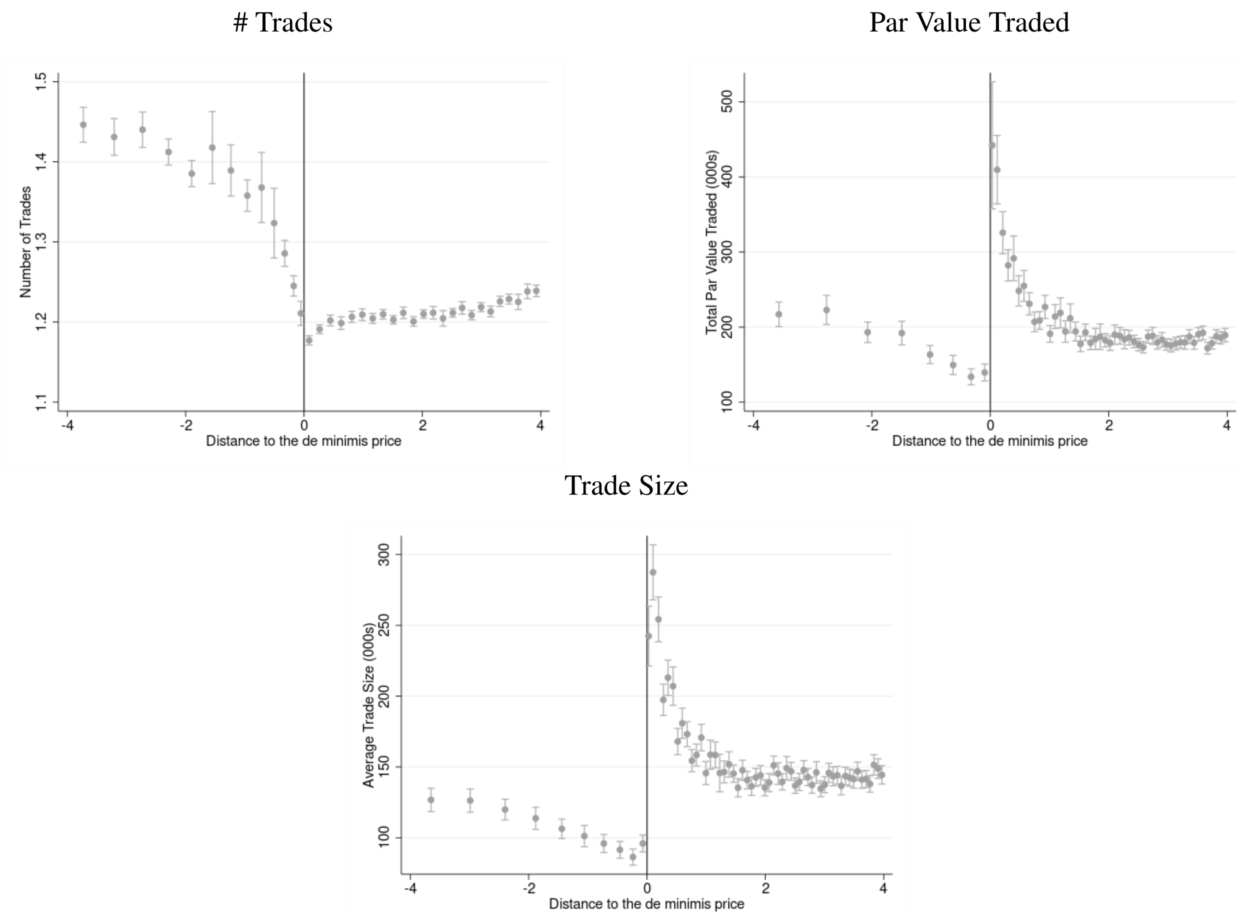
We utilize the Svensson extension of Nelson-Siegel (NSS) model to generate zero rates because the Nelson-Siegel zero curve has difficulty matching yields at long maturities. We train the NSS model for each trade type, separately, with the zero rates obtained above of up to 24, 23, and 11.5 years in maturity for small, medium, and large trades, respectively. We then rely on the model-generated zero rates to arrive at hypothetical yields for each remaining maturity-week-trade size combination. We utilize τ_1 and τ_2 values for the Svensson extension from Gurkaynak, Sack and Wright (2006), provided on the Federal Reserve's website.[20] Finally, we define yield spreads as the difference between yields of customer-to-dealer transactions around the de minimis threshold and the corresponding hypothetical yield. We use yields from both investor sales and purchase transactions in a sequential manner in the secondary market spreads computation. Given our focus on the ease with which investors dispose of municipal bonds, we first use yields from investor sales, if available. If in a given bond-week only investor purchase yields are available, we then use those values.

[20] https://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html

C Robustness Tests

In our main tests, we apply the equally-spaced IMSE optimal estimators of Calonico, Cattaneo and Titiunik (2015) to understand the evolution of municipal trading activity around the de minimis threshold. The following two figures present robustness checks to this approach using quantile-spaced plots that account for the sparsity of the underlying data (see Figure C.1) or polynomial regressions approximations of the means in each equally spaced bin, which better address noncontinuous outcomes (see Figure C.2).

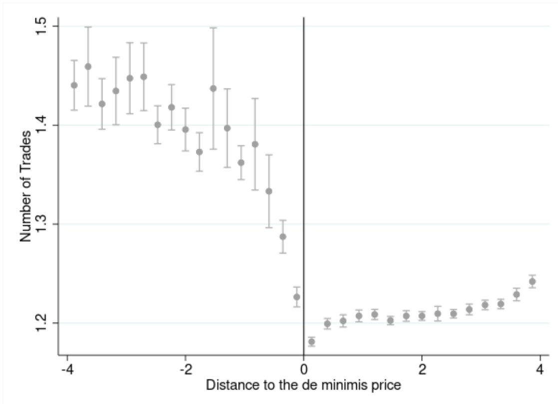
Figure C.1: Secondary Market Liquidity and the de minimis Price Threshold, Quantile Spaced Plots.



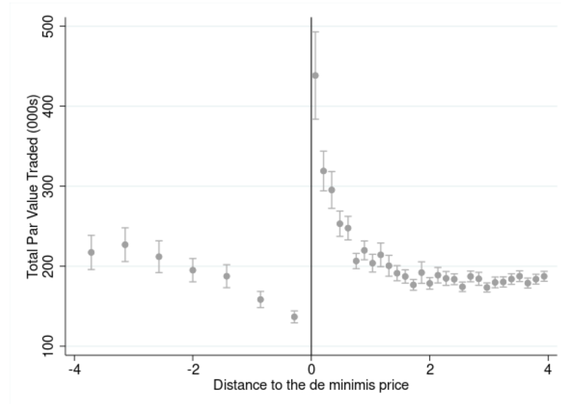
Note: Figure C.1 presents the distributions of three secondary market activity measures of municipal bonds around the de minimis threshold for tax-exempt boonds: the averages of the number of trades, total par value traded (in 000s of dollars), and trade size (in 000s of dollars) in a given week. We use customer-to-dealer sales transactions to construct these measures. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the de minimis price, where positive (negative) values indicate that trade prices are above (below) the de minimis price. We construct these plots using quantile spaced plots that account for the sparsity of the underlying data.

Figure C.2: Secondary Market Liquidity and the de minimis Price Threshold, Quantile Spaced Plots.

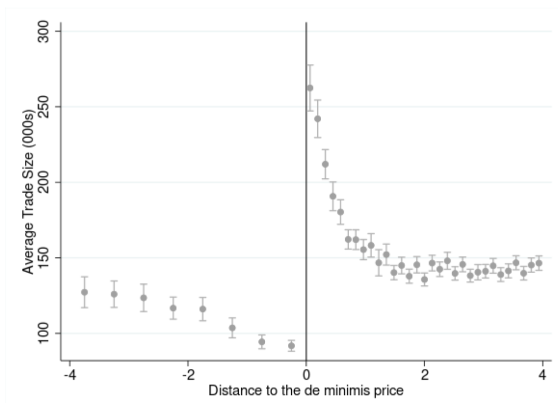
Trades



Par Value Traded



Trade Size

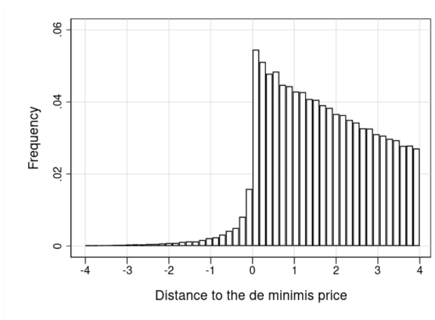


Note: Figure C.2 presents the distributions of three secondary market activity measures of municipal bonds around the de minimis threshold for tax-exempt bonds: the averages of the number of trades, total par value traded (in 000s of dollars), and trade size (in 000s of dollars) in a given week. We use customer-to-dealer sales transactions to construct these measures. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the de minimis price, where positive (negative) values indicate that trade prices are above (below) the de minimis price. We construct these plots using polynomial regressions approximations of the means in each equally spaced bin, an estimator that is better equipped to handle noncontinuous outcomes of interest.

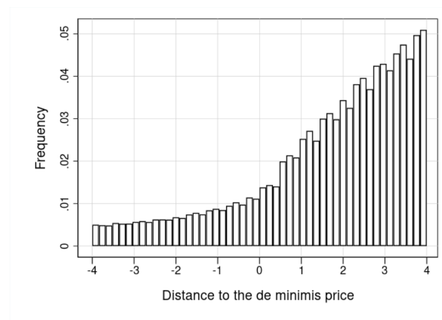
We also present sample splits across an alternative measure of bond sensitivity to interest rate risk—bond maturity. Short-term bonds typically have lower sensitivity to interest rate changes than longer-term bonds.

Figure C.3: Secondary Market Liquidity, the De Minimis Threshold, and Bond Maturity.

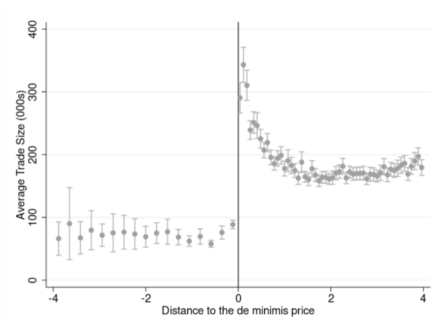
Weekly Trades Distribution, Short-term Bonds



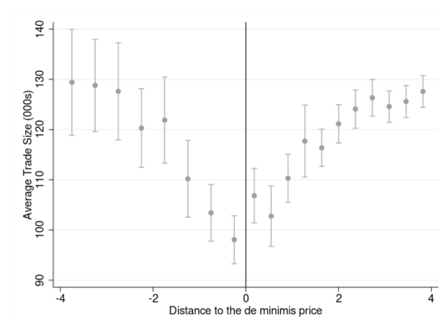
Weekly Trades Distribution, Long-term Bonds



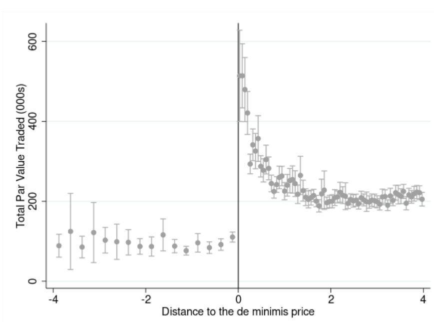
Avg. Trade Size, Short-term Bonds



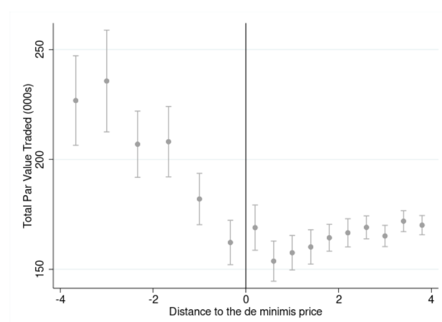
Avg. Trade Size, Long-term Bonds



Par Value Traded, Short-term Bonds



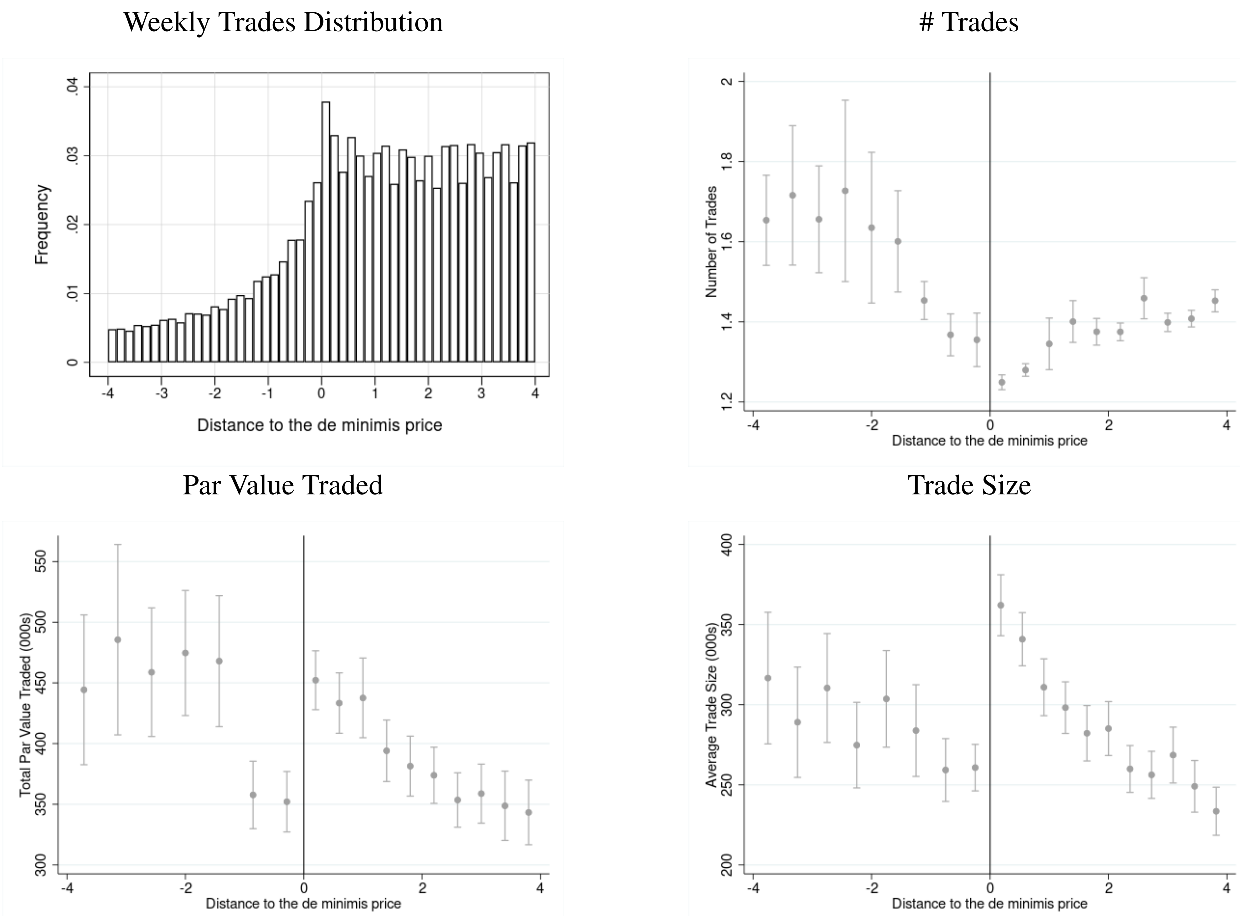
Par Value Traded, Long-term Bonds



Note: Figure C.3 presents the distributions of three measures of secondary municipal bond market activity around the de minimis threshold for short- and long-term bonds: the incidence of trading, and the averages of total par value traded (in 000s of dollars) and trade size (in 000s of dollars) in a given week. We use customer-to-dealer sales transactions to construct average total par value traded and trade size. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the de minimis price, where positive (negative) values indicate that the trade price is above (below) the deminimis price. Short-term bonds are those with maturities ≤ 2 years and long-term bonds are those with maturities > 2 years.

Earlier in the paper we show that investor segmentation arises because municipal bond mutual funds are sensitive to the tax treatment of price appreciation of tax-exempt municipal bonds. To the extent that taxable municipal bonds are held by less tax-sensitive investor clienteles, changes in liquidity around the de minimis threshold should be less pronounced than in the tax-exempt bonds case.

Figure C.4: Secondary Market Liquidity and the de minimis Price Threshold, Taxable Bonds.



Note: Figure C.4 presents the distributions of three secondary market activity measures of municipal bonds around the de minimis threshold for taxable bonds: the incidence of trading, and the averages of total par value traded (in 000s of dollars) and trade size (in 000s of dollars) in a given week. We use customer-to-dealer sales transactions to construct average total par value traded and trade size. The figure presents averages and 95% confidence intervals for each bin within the [-4,4] interval around the deminimis price, where positive (negative) values indicate that the trade price is above (below) the deminimis price. We limit the sample to taxable bonds.

Table C.1: Trading Characteristics Around the De Minimis Threshold

Table C.1 compares municipal bond trading activity below and above the de minimis threshold. The sample is limited to observations within four percentage points of the de minimis threshold, on either side of the threshold, for each bond-week observation. Rows labeled "below threshold" present summary statistics for bond-week observations that are from zero to four percentage points below the de minimis price, while bond-weeks "above threshold" refer to those from zero to four percentage points above the de minimis price (including bond-weeks at the de minimis price).

	Mean	SD	Obs	25^{th}	50^{th}	75^{th}
Dollar Volume, Small	13.68	11.91	1,196,436	10.00	10.00	20.00
Below threshold	13.88	14.97	193,873	10.00	10.00	20.00
Above threshold	13.65	11.22	1,002,563	10.00	10.00	20.00
Number of Trades, Small	1.15	1.58	1,196,436	1.00	1.00	1.00
Below threshold	1.24	2.77	193,873	1.00	1.00	1.00
Above threshold	1.14	1.22	1,002,563	1.00	1.00	1.00
Yield, Small	3.47	1.60	1,178,978	2.09	3.43	4.82
Below threshold	4.69	1.36	188,652	3.66	4.80	5.67
Above threshold	3.24	1.54	990,326	1.93	3.15	4.53
Dollar Volume, Medium	46.69	32.85	1,370,689	25.00	40.00	50.00
Below threshold	49.34	40.08	168,730	25.00	40.00	50.00
Above threshold	46.32	31.69	1,201,959	25.00	40.00	50.00
Number of Trades, Medium	1.13	0.65	1,370,689	1.00	1.00	1.00
Below threshold	1.22	0.85	168,730	1.00	1.00	1.00
Above threshold	1.12	0.62	1,201,959	1.00	1.00	1.00
Yield, Medium	2.76	1.65	1,355,202	1.35	2.34	4.07
Below threshold	4.40	1.35	165,803	3.51	4.43	5.49
Above threshold	2.53	1.56	1,189,399	1.25	2.06	3.67
Dollar Volume, Large	734.89	4391.14	739,403	100.00	200.00	400.00
Below threshold	888.29	3806.41	63,751	100.00	185.00	390.00
Above threshold	720.41	4442.07	675,652	100.00	200.00	400.00
Number of Trades, Large	1.11	0.63	739,403	1.00	1.00	1.00
Below threshold	1.20	0.92	63,751	1.00	1.00	1.00
Above threshold	1.11	0.60	675,652	1.00	1.00	1.00
Yield, Large	2.15	1.65	713,041	0.79	1.65	3.22
Below threshold	4.24	1.45	62,519	3.27	4.33	5.48
Above threshold	1.94	1.52	650,522	0.72	1.51	2.75

Table C.2: Mutual fund sales and yield spreads around the de minimis threshold.

Table C.2 reports regression estimates of $y_{b,w} = \sum_{i<-1}^{+4} \beta_i (Sales_{bq} \times Distance_{ibw}) + \gamma X_{b,w} + \varepsilon_{b,w}$, where $y_{b,w}$ is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and and the average yields of bonds above par with the same remaining maturity and in the same week. Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- or high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above the median. $Sales_{b,q-1}$ is an indicator variable that takes the value of one whenever the mutual fund industry reduces its exposure to bond b in the previous quarter $q-1$ by at least 25%. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{< -1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 25 years. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. Standard errors are double clustered at the week and bond level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Sales × Distance< -1	0.240***	0.162***	0.092*	0.266**	0.095***
	(0.046)	(0.044)	(0.049)	(0.119)	(0.026)
Sales × Distance$= -1$	0.633***	0.573***	0.338***	0.641***	0.073**
	(0.082)	(0.082)	(0.083)	(0.102)	(0.031)
Sales × Distance$= +1$	0.008	0.045**	-0.005	-0.113***	0.068**
	(0.023)	(0.021)	(0.016)	(0.025)	(0.026)
Sales × Distance$= +2$	-0.054***	-0.031**	-0.033***	-0.084***	0.083**
	(0.018)	(0.014)	(0.010)	(0.017)	(0.034)
Sales × Distance$= +3$	-0.054***	-0.023*	-0.023**	-0.068***	0.119***
	(0.018)	(0.013)	(0.010)	(0.016)	(0.039)
Sales × Distance$= +4$	0.004	0.018	0.000	-0.053***	0.124***
	(0.019)	(0.014)	(0.010)	(0.017)	(0.032)
Observations	2,608,151	2,570,697	1,035,903	1,044,289	1,549,159
R-squared	0.638	0.691	0.760	0.710	0.619
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table C.3: Quarterly turnover and yield spreads around the de minimis threshold.

Table C.3 reports regression estimates of $y_{b,w} = \sum_{i<-1}^{+4} \beta_i (Sales_{bq} \times Distance_{ibw}) + \gamma X_{b,w} + \varepsilon_{b,w}$, where $y_{b,w}$ is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and the average yields of bonds above par with the same remaining maturity and in the same week. Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- or high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above the median. $Low\ Turnover_{b,q-1}$ is an indicator variable that takes the value of one whenever a bond b is in the lowest (the first) quintile of quarterly turnover, or total quarterly trading volume of bond b divided by the dollar value outstanding of bond b as of the previous quarter $q-1$. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{<-1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 25 years. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. Standard errors are double clustered at the week and bond level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Low Turnover × Distance<-1	-0.010	-0.027**	-0.018	-0.020	0.042***
	(0.012)	(0.012)	(0.022)	(0.043)	(0.007)
Low Turnover × Distance$=-1$	0.081***	0.039*	0.068*	0.121***	0.057***
	(0.020)	(0.020)	(0.035)	(0.030)	(0.009)
Low Turnover × Distance$=+1$	0.072***	0.095***	0.013	0.069***	0.107***
	(0.011)	(0.010)	(0.012)	(0.014)	(0.010)
Low Turnover × Distance$=+2$	0.071***	0.101***	0.041***	-0.026**	0.177***
	(0.009)	(0.008)	(0.010)	(0.011)	(0.013)
Low Turnover × Distance$=+3$	0.085***	0.106***	0.035***	-0.087***	0.177***
	(0.008)	(0.007)	(0.009)	(0.010)	(0.012)
Low Turnover × Distance$=+4$	0.064***	0.080***	0.032***	-0.076***	0.118***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.009)
Observations	2,039,187	2,129,810	934,505	819,508	1,187,679
R-squared	0.668	0.709	0.790	0.745	0.648
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table C.4: Mutual fund sales and yield spreads: Nelson-Siegel method.

Table C.4 reports regression estimates of $y_{b,w} = \sum_{i<-1}^{+4} \beta_i(Sales_{bq} \times Distance_{ibw}) + \gamma X_{b,w} + \varepsilon_{b,w}$, where $y_{b,w}$ is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and hypothetical yields of bonds above par in the same week and with the same maturity computed using zero rates from the Nelson-Siegel method (Nelson and Siegel, 1987). Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- or high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above the median. $Sales_{b,q-1}$ is an indicator variable that takes the value of one whenever the mutual fund industry reduces its exposure to bond b in the previous quarter $q-1$ by at least 25%. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{< -1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 30 years. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. Standard errors are double clustered at the week and bond level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Sales × Distance< −1	0.216***	0.134***	0.061	0.354***	0.076***
	(0.047)	(0.045)	(0.048)	(0.111)	(0.024)
Sales × Distance= −1	0.775***	0.656***	0.374***	0.831***	0.069**
	(0.094)	(0.094)	(0.083)	(0.105)	(0.028)
Sales × Distance= +1	0.221***	0.226***	0.098***	0.026	0.043*
	(0.024)	(0.021)	(0.014)	(0.025)	(0.023)
Sales × Distance= +2	-0.012	-0.006	-0.001	-0.060***	0.046
	(0.016)	(0.013)	(0.009)	(0.016)	(0.031)
Sales × Distance= +3	-0.042**	-0.023*	-0.022**	-0.062***	0.095***
	(0.017)	(0.012)	(0.010)	(0.016)	(0.036)
Sales × Distance= +4	0.006	0.018	-0.000	-0.059***	0.119***
	(0.018)	(0.013)	(0.009)	(0.017)	(0.031)
Observations	2,696,934	2,647,489	1,071,215	1,068,038	1,614,431
R-squared	0.772	0.838	0.898	0.758	0.711
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table C.5: Quarterly turnover and yield spreads: Nelson-Siegel method.

Table C.5 reports regression estimates of $y_{b,w} = \sum_{i<-1}^{+4} \beta_i (Sales_{bq} \times Distance_{ibw}) + \gamma X_{b,w} + \varepsilon_{b,w}$, where $y_{b,w}$ is the yield spread, or the difference between yields of municipal bonds around the de minimis threshold and hypothetical yields of bonds above par in the same week and with the same maturity computed using zero rates from the Nelson-Siegel method (Nelson and Siegel, 1987). Columns 1, 2, and 3 restrict the sample to yield spreads for small, medium, and large trades, while columns 4 and 5 further partition the sample to small trades of low- or high-duration bonds, respectively. Low-duration bonds have duration below the sample median, while high-duration bonds have duration above the median. $Low\ Turnover_{b,q-1}$ is an indicator variable that takes the value of one whenever a bond b is in the lowest (the first) quintile of quarterly turnover, or total quarterly trading volume of bond b divided by the dollar value outstanding of bond b as of the previous quarter $q-1$. $Distance_{ibw}$ is an indicator variable that takes the value of one if the price of bond b price is within interval i around the de minimis threshold ($i \in \{<-1, -1, +1, +2, +3, +4\}$) in week w, and zero otherwise. We include bonds within 10 percentage points on either side of the threshold. We rely sequentially on customer sales and purchase transactions (in this order) to compute bond spreads. Finally, we exclude bonds with remaining maturities of over 30 years. The matrix X comprises of bond and week fixed effects as well as all $Distance_i$ indicators. Standard errors are double clustered at the week and bond level. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)	(5)
			Yield Spread		
Trade Size	Small	Medium	Large	Small	Small
Duration	—	—	—	Low	High
Low Turnover × Distance<-1	0.001	-0.003	0.024	0.005	0.048***
	(0.010)	(0.010)	(0.019)	(0.041)	(0.007)
Low Turnover × Distance$=-1$	0.090***	0.057***	0.094***	0.143***	0.063***
	(0.020)	(0.020)	(0.032)	(0.030)	(0.009)
Low Turnover × Distance$=+1$	0.078***	0.103***	0.027**	0.084***	0.098***
	(0.011)	(0.010)	(0.012)	(0.014)	(0.009)
Low Turnover × Distance$=+2$	0.077***	0.103***	0.037***	-0.005	0.176***
	(0.008)	(0.007)	(0.010)	(0.011)	(0.012)
Low Turnover × Distance$=+3$	0.087***	0.106***	0.035***	-0.082***	0.182***
	(0.007)	(0.007)	(0.009)	(0.009)	(0.012)
Low Turnover × Distance$=+4$	0.067***	0.081***	0.034***	-0.081***	0.124***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.009)
Observations	2,091,728	2,178,105	961,860	842,566	1,217,578
R-squared	0.782	0.851	0.919	0.777	0.743
Bond FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y